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ON THE

REDUCTION OF THE BAROMETER TO SEA LEVEL.

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The application of an approximately correct reduction to barometric readings, taken at various levels, in order to reduce them to what they would have been at one specified level, is absolutely necessary for their intercomparison. In the following paper several formulæ which have been employed for this purpose are examined; and tables are appended by means of which, with very little calculation, a sufficiently correct reduction may be obtained, and which are, moreover, peculiarly adapted to the computation of tables of reduction for individual stations.

Guyot's Tables* D, XVI. and XIX'., are commonly employed, on this continent, for the purpose of effecting the reduction. These give the height, in English feet, of a column of air corresponding to a tenth of an inch in the barometer at various temperatures, the barometric pressure at the base of the column being from 22 inches to 30·4 inches.

A formula is given for use with Table XVI., which may be written

$$R = \frac{Z}{N} \times \frac{\beta}{10b}, \qquad \text{(i.)}$$

where R represents the required reduction in inches, Z the difference of height between the two stations, or the height above the sea (expressed in feet), N the number in the table, β the observed reading of the barometer reduced to 32° Fahr., and b the pressure on which the tabular number N is based,† that is, 30 inches.

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* Meteorological and Physical Tables. Third edition. Washington, 1859. By Arnold Guyot, P.D., LL.D., Professor of Geology and Physical Geography, College of New Jersey.

† Guyot defines what is here represented by b, as "the normal height of barometer at the sea-level," and in an example which he gives, he employs 30 in. It is, however, only because the table is based on a barometric reading of 30 in., that this value of b is to be employed.

No formula is given for use with Table XIX.′, but it is stated that the table may be employed "for reducing barometrical observations to the level of the sea, and also to any other level by a similar process." An example is, however, given, applying tables in French measure, corresponding to XIX.′, the method of which example may be represented by the formula

$$B = \frac{2Z}{{}_{\beta}N_{t} + {}_{B}N_{T}} \cdot \frac{1}{10}, \qquad \text{(ii.)}$$

where ${}_{\beta}N_{t}$ is the number in the table corresponding to the barometric reading* and temperature at the upper station, and ${}_{B}N_{T}$ that corresponding to those at the lower station; an approximate reduced barometric reading and temperature being employed in taking out the latter quantity.

Formula (i.) may also be employed with Table XIX.′, b being any height and N the number in the table corresponding to b. No advantage is, however, gained, by using this table instead of Table XVI. with formula (i.), unless b be taken nearly equal to β, so that we may have, nearly

$$B = \frac{Z}{10N}.$$

Laplace's formula for computing differences of elevation from barometrical observations, from which each of the above is deduced, may be written

$$Z = A_{t} \log \frac{B}{\beta}, \qquad \text{(iii.)}$$

where A_{t} is a constant, depending on the mean between the temperatures at the upper and lower stations. Strictly, it also depends upon the latitude of the station, and on the height above the sea; but the variations due to these may be neglected, unless the height is very considerable.

Now the number ${}_{b}N_{t}$, in the above mentioned tables, for barometer reading b, and temperature t, is the difference of elevation

* Throughout this paper, when a barometric reading is spoken of, the reading reduced to temp. 32° Fahr. is to be understood.

of two stations, the temperature being t, the barometer reading at lower station b, and at the upper station $b - \frac{1}{10}$. Hence, by (iii.),

$$_bN_t = A_t \log \frac{b}{b - \frac{1}{10}}.$$

Also R being the reduction, (iii.) may be written

$$Z = A_t \log \frac{\beta + R}{\beta}.$$

Combining these, we get

$$\log \left(1 + \frac{R}{\beta}\right) = \frac{Z}{_bN_t} \log \frac{10\,b}{10\,b - 1};$$

hence,
$$1 + \frac{R}{\beta} = \left(\frac{10\,b}{10\,b - 1}\right)^{\frac{Z}{_bN_t}} = \left(1 - \frac{1}{10\,b}\right)^{-\frac{Z}{_bN_t}}$$

$$= 1 + \frac{Z}{_bN_t} \cdot \frac{1}{10\,b} + \frac{1}{1.2} \cdot \frac{Z}{_bN_t} \cdot \overline{\frac{Z}{_bN_t} + 1} \cdot \overline{\frac{1}{10\,b}}\Big|^2 + \ldots.$$

by the binomial theorem.

$$\therefore R = \beta\left(\frac{Z}{_bN_t} \cdot \frac{1}{10\,b} + \frac{1}{1.2} \cdot \frac{Z}{_bN_t} \cdot \overline{\frac{Z}{_bN_t} + 1} \cdot \overline{\frac{1}{10\,b}}\Big|^2 + \ldots.\right) \quad \text{(iv.)}$$

Formula (i.) is deduced from (iv.), by neglecting all terms beyond the first; and making $b = 30$ inches, if used with Table XVI.; but, if used with Table XIX.′, b may be any reading within the range of the table, and $_bN_t$ the *corresponding* number from the table.

Although (i.) is sufficiently accurate for small heights, it is evident, on comparing it with the full formula (iv.), that it becomes more and more inaccurate as the height increases.

If, in (i.), the reduced height B, were substituted for the observed height β, the error would be relatively less; for Laplace's formula may also be expanded in the form

$$R = B\left(\frac{Z}{_bN_t} \cdot \frac{1}{10\,b} - \frac{1}{1.2} \cdot \frac{Z}{_bN} \cdot \overline{\frac{Z}{_bN} - 1} \cdot \overline{\frac{1}{10\,b}}\Big|^2 + \ldots.\right) \quad \text{(v.)}$$

In this formula each term, after the first, is relatively smaller than the corresponding term in (iv.); and if $\frac{Z}{{}_bN_t}$ is large, the terms having sensible magnitude, are alternately positive and negative. Therefore the error, introduced by neglecting all terms beyond the first, is relatively less in (v.) than in (iv.); but, since B is not known until R has been determined, this formula could only be employed by successive approximation, and is therefore inconvenient.

It may be seen by inspection that, in Table XIX.′, ${}_BN_t$ is very nearly equal to $\frac{\beta}{B} \cdot {}_\beta N_t$. That this should be so, may be proved thus :—

As already explained

$${}_BN_t = A_t \log \frac{10\,B}{10\,B - 1},$$

$${}_\beta N_t = A_t \log \frac{10\,\beta}{10\,\beta - 1}.$$

$$\therefore \frac{{}_BN_t}{{}_\beta N_t} = \frac{\log \frac{10\,B}{10\,B-1}}{\log \frac{10\,\beta}{10\,\beta - 1}} = \frac{\log\left(1 - \frac{1}{10\,B}\right)}{\log\left(1 - \frac{1}{10\,\beta}\right)}\,.$$

$$= \frac{\frac{1}{10\,B} + \frac{1}{2}\cdot\overline{\frac{1}{10\,B}}\Big|^2 + \ldots.}{\frac{1}{10\,\beta} + \frac{1}{2}\cdot\overline{\frac{1}{10\,\beta}}\Big|^2 + \ldots.}\,.$$

$$= \frac{\beta}{B} \text{ nearly,} \qquad \text{(vi.)}$$

$$\therefore {}_BN_t = \frac{\beta}{B} \cdot {}_\beta N_t \text{ nearly, as above stated.}$$

From (iv.) and (v.), together with (vi.), we may deduce (ii.), thus: In (iv.), let $b = \beta$, we obtain

$$R = \frac{Z}{{}_{\beta}N_t} \cdot \frac{1}{10} + \frac{1}{1.2} \cdot \frac{Z}{{}_{\beta}N_t} \cdot \overline{\frac{Z}{{}_{\beta}N_t} + 1} \cdot \frac{1}{100\beta} + \cdots$$

$$\therefore {}_{\beta}N_t \cdot R = \frac{Z}{10} + \frac{1}{1.2} \cdot \frac{Z}{10} \cdot \overline{\frac{Z}{{}_{\beta}N_t} + 1} \cdot \frac{1}{10\beta} + \cdots$$

Similarly from (v.) making $b = B$,

$${}_{B}N_t \cdot R = \frac{Z}{10} - \frac{1}{1.2} \cdot \frac{Z}{10} \cdot \overline{\frac{Z}{{}_{B}N_t} - 1} \cdot \frac{1}{10B} + \cdots$$

$$\therefore \left({}_{\beta}N_t + {}_{B}N_t\right) R = \frac{2Z}{10} + \frac{1}{1.2} \cdot \frac{Z}{10} \cdot \left(\frac{Z}{10\beta . {}_{\beta}N_t} - \frac{Z}{10B . {}_{B}N_t} + \frac{1}{10\beta} + \frac{1}{10B}\right) + \cdots$$

But from (vi.) $B . {}_{B}N_t = \beta . {}_{\beta}N_t$ nearly.

$$\therefore \left({}_{\beta}N_t + {}_{B}N_t\right) R = \frac{2Z}{10} + \frac{1}{1.2} \cdot \frac{Z}{10} \cdot \left(\frac{1}{10\beta} + \frac{1}{10B}\right) \text{ nearly,}$$

or, neglecting the second term on the right,

$$R = \frac{2Z}{{}_{\beta}N_t + {}_{B}N_t} \cdot \frac{1}{10} \text{ nearly.}$$

Here t is the mean between the temperatures at the upper and lower stations; whilst in (ii.) these two temperatures are respectively employed, in taking out the two numbers. The difference thus introduced is very trifling; as may easily be seen, if the value given below for A_t, be substituted in the expression for N_t.

Formula (ii.), like (v.), is objectionable, in that it assumes a knowledge of the reduced reading, which it is the object to ascertain.

The foregoing formulæ being all either inconvenient, or not sufficiently accurate except for small elevations, I have formed the accompanying tables (A and B), to facilitate the calculation of the reduction.

It will be noticed from the form of (iii.) that, at any place, the temperature being constant, the reduced reading, and therefore *also the reduction, varies as* β. It is, therefore, sufficient to calculate the reduction ${}_{Z}N_{t}$, for one barometer reading (b) only; from which that for any other reading may be obtained by a simple proportion. It is immaterial whether the value adopted for b be one which could be attained, or not; it may therefore be chosen with reference to convenience alone. In Table A, b is taken equal to 100 inches, so that the reduction for any reading (β) of the barometer, may be obtained by the formula

$$R = \frac{\beta}{100} \cdot {}_{Z}N_{t}.$$

Table A was calculated by means of formula (iii.), the value of A_t being taken as* $60345.51\left(1 + \frac{t - 32}{450}\right)$. In this table is given the quantity ${}_{Z}N_{t}$, for values of Z equal to 100, 200, 300, &c. feet, for every second degree of temperature from $-40°$ to $100°$ Fahr., and also, the difference for the next 100 feet at each height. It is sufficient to employ first differences only, in using the table.

Table B is intended to diminish the labour in applying formula (iii.), as will be explained in the sequel.

Since calculating these tables, my attention has been called to a paper by Lieut. H. H. C. Dunwoody, U. S. Army, in the Report of the Chief Signal Officer, Washington, 1876. In this paper tables are given, based in part on observations taken by direction of the Chief Signal Officer, U. S. A., on Mount Washington, Mount Mitchell, and Pikes Peak.

In the first table is given the decrease of temperature for each 100 feet of elevation at each hour in the day. In the second table is given the "weight of a column of air 100 feet high, at different barometric pressures and temperatures, expressed in decimals of an inch, calculated for north latitude 40°." The third table "shows a

* See Guyot's Paper D, pp. 9 and 88.

small empirical correction, determined from accurate comparison of reduced readings and actual observations, to be applied to Table II." A formula is also given, which may be written $R = (N + N')\,Z$, in which N is the number from Table II., and N' that from Table III.

If we compare this formula with (iv.), it is evident that some correction to N is necessary, since R does not *vary as* Z. The correction should, however, depend on the reading of the barometer (β) as well as on Z and t; but the empirical correction N' is given without regard to β.

The constants and formula, on which Table II. is based, are not given; and the rate of variation of the numbers, with the pressure, seems to deviate more than it should, from Boyle's Law.

Lieut. Dunwoody's Tables have not, so far as I am aware, been anywhere brought into use. The results given by his Tables II. and III. do not, however, differ much at moderate altitudes from those given by Table A, as will be seen from the following examples:

EXAMPLES OF THE USE OF TABLE A.

Example (1).—At a station 815 ft. above the sea, the reading of the barometer being 29.112 in., the temperature of the air 46° Fahr., to find the reduced reading.

From Table A we find ${}_{800}N_{46} = 3.0047$, and the difference for 100 ft. $= 0.3819$.

Hence the reduction,

$$R = \left(3.0047 + \frac{15}{100} \times 0.3819\right) \times 0.29112 = 3.0620 \times 0.29112$$
$$= 0.891,$$

and the reduced reading is 30.003.

Guyot's tables D, XVI. and XIX.' used with formula (i.), each give, for this reduction, 0.876 in. Lieut. Dunwoody's tables (ii.) and (iii.) give 0.890.

Example (2).—At a station 1100 ft. above the sea, the reading of the barometer being 28 in., the temperature of the air 30° Fahr., to find the reduction to sea level.

Here ${}_{1000}N_{30} = 3.9071$, and the difference for 100 ft. is 0.3990,

hence $$R = (3.9071 + 0.3990) \times 0{\cdot}28 = 4.3061 \times 0.28$$
$$= 1.206.$$

Guyot's Tables D, XVI. and XIX.', if extended, used with formula (i.), would give in this case 1.179, and Lieut. Dunwoody's give 1.204.

The value of Table A does not, however, consist so much in supplying a basis for working out isolated examples, as in furnishing data, in a convenient form, for the calculation of tables of reduction to sea level, for individual stations. To construct these all that is necessary is, first, to obtain the numbers ${}_{Z}N_{t}$ for every second degree of temperature, the value assigned to Z being the height of the cistern of the barometer above the sea; and then, to multiply these numbers by $\frac{b}{100}$, and tabulate the values of the reduction so obtained for values of b, between convenient limits, and at larger or smaller intervals, according as the station is at a slight or considerable elevation above the sea. The products for any given temperature need not be obtained separately, but may be found, one from another, by continued addition, and the whole process may be very quickly performed with the aid of the Arithmometer of Thomas de Colmar, for use with which the table is specially adapted.

The time occupied in forming a table in this way, is less than one half of what is required if the formula of Laplace (iii. of this paper) be employed.

For stations more than 1100 ft. above the sea, Table B (from which Table A was deduced) may be employed. In this table the values of $\frac{100{,}000}{A_t}$ are given; so that if N_t is the number in the table for temperature t, formula iii. becomes

$$\log \frac{B}{\beta} = \frac{Z}{100{,}000} N_t ,$$

$$\text{or } \log B = \frac{Z}{100{,}000} N_t + \log \beta .$$

For isolated examples this form is sufficiently convenient; but, in constructing a table for any station, it is better to make $\beta = 100$. The formula then becomes

$$\log \left(100 + {}_{Z}N_t\right) = \frac{Z}{100{,}000} N_t + 2 ,$$

and the table may be calculated from the value of ${}_{Z}N_{t}$ in the same way as when Table A is employed.

A table for reducing the barometer to sea level is furnished from the Central Office, Toronto, to each station in connection with the Meteorological Service of the Dominion.

Formerly these were computed directly from formula iii. (using a slightly different constant from that given above.) The accompanying tables were recently calculated to diminish the labour of computation.

In Canada, no reduction for height is applied to the observed temperature of the air; as, although some correction might be of advantage, it is by no means certain that a correction, obtained from observations on a mountain, would be suited to a station on an elevated table-land. The correction, if it were applied, would, however, be very small at nearly all our stations.

I hope to discuss, more fully, on some future occasion the question of the necessity for a correction to the observed temperature of the air in reducing barometric readings.

TABLE A.

Giving the value of $\frac{N}{Z\ t}$ for various temperatures and elevations, and the difference for an additional 100 feet at each height.

Temperature.	100 Feet.		200 Feet.		300 Feet.		400 Feet.		500 Feet.		Temperature.
	$\frac{N}{Z\ t}$	Diff. for 100 ft.	$\frac{N}{Z\ t}$	Diff. for 100 ft.	$\frac{N}{Z\ t}$	Diff. for 100 ft.	$\frac{N}{Z\ t}$	Diff. for 100 ft.	$\frac{N}{Z\ t}$	Diff. for 100 ft.	
—40°	0.4553	.4573	0.9126	.4595	1.3721	.4615	1.8336	.4636	2.2972	.4658	—40°
—38	0.4529	.4549	0.9078	.4570	1.3648	.4590	1.8238	.4612	2.2850	.4632	—38
—36	0.4505	.4525	0.9030	.4546	1.3576	.4566	1.8142	.4587	2.2729	.4607	—36
—34	0.4482	.4501	0.8983	.4522	1.3505	.4542	1.8047	.4562	2.2609	.4583	—34
—32	0.4458	.4478	0.8936	.4498	1.3434	.4519	1.7953	.4538	2.2491	.4558	—32
—30	0.4435	.4455	0.8890	.4475	1.3365	.4494	1.7859	.4515	2.2374	.4534	—30
—28	0.4412	.4432	0.8844	.4452	1.3296	.4471	1.7767	.4491	2.2258	.4510	—28
—26	0.4390	.4409	0.8799	.4428	1.3227	.4448	1.7675	.4468	2.2143	.4487	—26
—24	0.4368	.4386	0.8754	.4406	1.3160	.4425	1.7585	.4444	2.2029	.4464	—24
—22	0.4345	.4365	0.8710	.4383	1.3093	.4402	1.7495	.4422	2.1917	.4440	—22
—20	0.4324	.4342	0.8666	.4361	1.3027	.4380	1.7407	.4398	2.1805	.4418	—20
—18	0.4302	.4320	0.8622	.4339	1.2961	.4358	1.7319	.4376	2.1695	.4395	—18
—16	0.4280	.4299	0.8579	.4317	1.2896	.4336	1.7232	.4354	2.1586	.4373	—16
—14	0.4259	.4277	0.8536	.4296	1.2832	.4314	1.7146	.4332	2.1478	.4351	—14
—12	0.4238	.4256	0.8494	.4274	1.2768	.4293	1.7061	.4310	2.1371	.4329	—12
—10	0.4217	.4235	0.8452	.4253	1.2705	.4271	1.6976	.4289	2.1265	.4307	—10
— 8	0.4197	.4214	0.8411	.4232	1.2643	.4250	1.6893	.4267	2.1160	.4286	— 8
— 6	0.4176	.4194	0.8370	.4211	1.2581	.4229	1.6810	.4247	2.1057	.4264	— 6
— 4	0.4156	.4173	0.8329	.4191	1.2520	.4208	1.6728	.4226	2.0954	.4243	— 4
— 2	0.4136	.4153	0.8289	.4171	1.2460	.4187	1.6647	.4205	2.0852	.4222	— 2
0	0.4116	.4133	0.8249	.4151	1.2400	.4167	1.6567	.4184	2.0751	.4202	0
2	0.4097	.4113	0.8210	.4130	1.2340	.4147	1.6487	.4164	2.0651	.4182	2
4	0.4077	.4094	0.8171	.4110	1.2281	.4128	1.6409	.4144	2.0553	.4160	4
6	0.4058	.4074	0.8132	.4091	1.2223	.4107	1.6330	.4125	2.0455	.4141	6
8	0.4039	.4055	0.8094	.4071	1.2165	.4088	1.6253	.4105	2.0358	.4121	8
10	0.4020	.4036	0.8056	.4052	1.2108	.4069	1.6177	.4085	2.0262	.4101	10
12	0.4001	.4017	0.8018	.4033	1.2051	.4050	1.6101	.4065	2.0166	.4082	12
14	0.3982	.3999	0.7981	.4014	1.1995	.4031	1.6026	.4046	2.0072	.4063	14
16	0.3964	.3980	0.7944	.3996	1.1940	.4011	1.5951	.4028	1.9979	.4043	16
18	0.3946	.3961	0.7907	.3978	1.1885	.3992	1.5877	.4009	1.9886	.4025	18
20	0.3928	.3943	0.7871	.3959	1.1830	.3974	1.5804	.3990	1.9794	.4006	20
22	0.3910	.3925	0.7835	.3941	1.1776	.3956	1.5732	.3972	1.9704	.3987	22
24	0.3892	.3908	0.7800	.3922	1.1722	.3938	1.5660	.3954	1.9614	.3968	24
26	0.3875	.3889	0.7764	.3905	1.1669	.3920	1.5589	.3935	1.9524	.3951	26
28	0.3857	.3872	0.7729	.3888	1.1617	.3902	1.5519	.3917	1.9436	.3932	28

TABLE A.—*Continued.*

Temperature.	600 FEET.		700 FEET.		800 FEET.		900 FEET.		1000 FEET.		Temperature.
	$\frac{N}{Z\ t}$	Diff. for 100 ft.	$\frac{N}{Z\ t}$	Diff. for 100 ft.	$\frac{N}{Z\ t}$	Diff. for 100 ft.	$\frac{N}{Z\ t}$	Diff. for 100 ft.	$\frac{N}{Z\ t}$	Diff. for 100 ft.	
—40°	2.7630	.4678	3.2308	.4700	3.7008	.4721	4.1729	.4743	4.6472	.4764	—40°
—38	2.7482	.4653	3.2135	.4675	3.6810	.4695	4.1505	.4717	4.6222	.4738	—38
—36	2.7336	.4629	3.1965	.4649	3.6614	.4670	4.1284	.4690	4.5974	.4713	—36
—34	2.7192	.4603	3.1795	.4624	3.6419	.4645	4.1064	.4666	4.5730	.4686	—34
—32	2.7049	.4579	3.1628	.4599	3.6227	.4620	4.0847	.4640	4.5487	.4661	—32
—30	2.6908	.4555	3.1463	.4574	3.6037	.4595	4.0632	.4616	4.5248	.4636	—30
—28	2.6768	.4531	3.1299	.4550	3.5849	.4571	4.0420	.4591	4.5011	.4611	—28
—26	2.6630	.4507	3.1137	.4526	3.5663	.4546	4.0209	.4567	4.4776	.4586	—26
—24	2.6493	.4483	3.0976	.4503	3.5479	.4522	4.0001	.4543	4.4544	.4562	—24
—22	2.6357	.4460	3.0817	.4480	3.5297	.4498	3.9795	.4519	4.4314	.4538	—22
—20	2.6223	.4437	3.0660	.4456	3.5116	.4475	3.9591	.4495	4.4086	.4514	—20
—18	2.6090	.4414	3.0504	.4433	3.4937	.4453	3.9390	.4471	4.3861	.4490	—18
—16	2.5959	.4391	3.0350	.4411	3.4761	.4429	3.9190	.4448	4.3638	.4467	—16
—14	2.5829	.4369	3.0198	.4388	3.4586	.4406	3.8992	.4425	4.3417	.4444	—14
—12	2.5700	.4347	3.0047	.4365	3.4412	.4384	3.8796	.4403	4.3199	.4421	—12
—10	2.5572	.4325	2.9897	.4344	3.4241	.4362	3.8603	.4380	4.2983	.4398	—10
— 8	2.5446	.4303	2.9749	.4322	3.4071	.4340	3.8411	.4358	4.2769	.4376	— 8
— 6	2.5321	.4282	2.9603	.4300	3.3903	.4318	3.8221	.4336	4.2557	.4354	— 6
— 4	2.5197	.4261	2.9458	.4278	3.3736	.4297	3.8033	.4314	4.2347	.4332	— 4
— 2	2.5074	.4240	2.9314	.4257	3.3571	.4275	3.7846	.4293	4.2139	.4310	— 2
0	2.4953	.4219	2.9172	.4236	3.3408	.4254	3.7662	.4271	4.1933	.4289	0
2	2.4833	.4198	2.9031	.4215	3.3246	.4233	3.7479	.4250	4.1729	.4268	2
4	2.4713	.4178	2.8891	.4195	3.3086	.4212	3.7298	.4230	4.1528	.4246	4
6	2.4596	.4157	2.8753	.4175	3.2928	.4191	3.7119	.4209	4.1328	.4225	6
8	2.4479	.4137	2.8616	.4153	3.2769	.4173	3.6942	.4188	4.1130	.4205	8
10	2.4363	.4118	2.8481	.4134	3.2615	.4151	3.6766	.4168	4.0934	.4184	10
12	2.4248	.4098	2.8346	.4115	3.2461	.4131	3.6592	.4147	4.0739	.4165	12
14	2.4135	.4078	2.8213	.4095	3.2308	.4111	3.6419	.4128	4.0547	.4144	14
16	2.4022	.4059	2.8081	.4076	3.2157	.4092	3.6249	.4107	4.0356	.4125	16
18	2.3911	.4040	2.7951	.4056	3.2007	.4072	3.6079	.4089	4.0168	.4104	18
20	2.3800	.4021	2.7821	.4038	3.1859	.4053	3.5912	.4069	3.9981	.4085	20
22	2.3691	.4002	2.7693	.4019	3.1712	.4034	3.5746	.4049	3.9795	.4066	22
24	2.3582	.3984	2.7566	.4000	3.1566	.4015	3.5581	.4031	3.9612	.4046	24
26	2.3475	.3965	2.7440	.3981	3.1421	.3997	3.5418	.4012	3.9430	.4027	26
28	2.3368	.3948	2.7316	.3962	3.1278	.3978	3.5256	.3994	3.9250	.4008	28

TABLE A.—*Continued.*

Temperature.	100 Feet.		200 Feet.		300 Feet.		400 Feet.		500 Feet.		Temperature.
	$\frac{N}{Z\,t}$	Diff. for 100 ft.	$\frac{N}{Z\,t}$	Diff. for 100 ft.	$\frac{N}{Z\,t}$	Diff. for 100 ft.	$\frac{N}{Z\,t}$	Diff. for 100 ft.	$\frac{N}{Z\,t}$	Diff. for 100 ft.	
30°	0.3840	.3855	0.7695	.3869	1.1564	.3885	1.5449	.3899	1.9348	.3915	30°
32	0.3823	.3838	0.7661	.3852	1.1513	.3867	1.5380	.3882	1.9262	.3896	32
34	0.3806	.3820	0.7626	.3836	1.1462	.3849	1.5311	.3864	1.9175	.3879	34
36	0.3789	.3804	0.7593	.3818	1.1411	.3832	1.5243	.3847	1.9090	.3862	36
38	0.3773	.3786	0.7559	.3801	1.1360	.3816	1.5176	.3830	1.9006	.3844	38
40	0.3756	.3770	0.7526	.3785	1.1311	.3798	1.5109	.3813	1.8922	.3827	40
42	0.3740	.3753	0.7493	.3768	1.1261	.3782	1.5043	.3796	1.8839	.3810	42
44	0.3723	.3738	0.7461	.3751	1.1212	.3765	1.4977	.3780	1.8757	.3793	44
46	0.3707	.3722	0.7429	.3734	1.1163	.3749	1.4912	.3763	1.8675	.3777	46
48	0.3691	.3706	0.7397	.3718	1.1115	.3733	1.4848	.3746	1.8594	.3760	48
50	0.3676	.3689	0.7365	.3703	1.1068	.3716	1.4784	.3730	1.8514	.3744	50
52	0.3660	.3673	0.7333	.3687	1.1020	.3700	1.4720	.3714	1.8434	.3728	52
54	0.3644	.3658	0.7302	.3671	1.0973	.3685	1.4658	.3698	1.8356	.3711	54
56	0.3629	.3642	0.7271	.3656	1.0927	.3668	1.4595	.3682	1.8277	.3696	56
58	0.3614	.3627	0.7241	.3640	1.0881	.3653	1.4534	.3666	1.8200	.3679	58
60	0.3599	.3611	0.7210	.3625	1.0835	.3637	1.4472	.3651	1.8123	.3664	60
62	0.3584	.3596	0.7180	.3609	1.0789	.3623	1.4412	.3635	1.8047	.3648	62
64	0.3569	.3581	0.7150	.3594	1.0744	.3607	1.4351	.3620	1.7971	.3633	64
66	0.3554	.3566	0.7120	.3580	1.0700	.3592	1.4292	.3604	1.7896	.3618	66
68	0.3539	.3552	0.7091	.3564	1.0655	.3577	1.4232	.3590	1.7822	.3602	68
70	0.3525	.3537	0.7062	.3550	1.0612	.3562	1.4174	.3574	1.7748	.3588	70
72	0.3510	.3523	0.7033	.3535	1.0568	.3547	1.4115	.3560	1.7675	.3573	72
74	0.3496	.3508	0.7004	.3521	1.0525	.3533	1.4058	.3545	1.7603	.3557	74
76	0.3482	.3494	0.6976	.3506	1.0482	.3518	1.4000	.3531	1.7531	.3543	76
78	0.3468	.3480	0.6948	.3492	1.0440	.3504	1.3944	.3516	1.7460	.3529	78
80	0.3454	.3466	0.6920	.3477	1.0397	.3490	1.3887	.3502	1.7389	.3514	80
82	0.3440	.3452	0.6892	.3464	1.0356	.3475	1.3831	.3488	1.7319	.3499	82
84	0.3426	.3438	0.6864	.3450	1.0314	.3462	1.3776	.3473	1.7249	.3486	84
86	0.3413	.3424	0.6837	.3436	1.0273	.3448	1.3721	.3459	1.7180	.3471	86
88	0.3399	.3411	0.6810	.3422	1.0232	.3434	1.3666	.3446	1.7112	.3457	88
90	0.3386	.3397	0.6783	.3409	1.0192	.3420	1.3612	.3432	1.7044	.3443	90
92	0.3372	.3384	0.6756	.3395	1.0151	.3407	1.3558	.3418	1.6976	.3430	92
94	0.3359	.3371	0.6730	.3382	1.0112	.3393	1.3505	.3404	1.6909	.3416	94
96	0.3346	.3358	0.6704	.3368	1.0072	.3380	1.3452	.3391	1.6843	.3403	96
98	0.3333	.3344	0.6677	.3356	1.0033	.3366	1.3399	.3378	1.6777	.3389	98
100	0.3320	.3332	0.6652	.3342	0.9994	.3353	1.3347	.3365	1.6712	.3376	100

TABLE A.—*Continued.*

Temperature.	600 Feet.		700 Feet.		800 Feet.		900 Feet.		1000 Feet.		Temperature.
	N / Z t	Diff. for 100 ft.	N / Z t	Diff. for 100 ft.	N / Z t	Diff. for 100 ft.	N / Z t	Diff. for 100 ft.	N / Z t	Diff. for 100 ft.	
30°	2.3263	.3929	2.7192	.3945	3.1137	.3959	3.5096	.3975	3.9071	.3990	30°
32	2.3158	.3912	2.7070	.3926	3.0996	.3941	3.4937	.3957	3.8894	.3972	32
34	2.3054	.3894	2.6948	.3909	3.0857	.3923	3.4780	.3939	3.8719	.3953	34
36	2.2952	.3876	2.6828	.3891	3.0719	.3905	3.4624	.3921	3.8545	.3935	36
38	2.2850	.3859	2.6709	.3873	3.0582	.3888	3.4470	.3903	3.8373	.3917	38
40	2.2749	.3842	2.6591	.3855	3.0446	.3871	3.4317	.3885	3.8202	.3899	40
42	2.2649	.3824	2.6473	.3839	3.0312	.3853	3.4165	.3868	3.8033	.3882	42
44	2.2550	.3807	2.6357	.3822	3.0179	.3836	3.4015	.3850	3.7865	.3864	44
46	2.2452	.3790	2.6242	.3805	3.0047	.3819	3.3866	.3833	3.7699	.3847	46
48	2.2354	.3774	2.6128	.3788	2.9916	.3802	3.3718	.3816	3.7534	.3830	48
50	2.2258	.3757	2.6015	.3771	2 9786	.3785	3.3571	.3799	3.7370	.3813	50
52	2.2162	.3741	2.5903	.8755	2.9658	.3768	3.3426	.3783	3.7209	.3796	52
54	2.2067	.3725	2.5792	.3738	2.9530	.3752	3.3282	.3766	3.7048	.3779	54
56	2.1973	.3709	2.5682	.3722	2.9404	.3735	3.3139	.3750	3.6889	.3763	56
58	2.1879	.3693	2.5572	.3706	2.9278	.3720	3.2998	.3733	3.6731	.3747	58
60	2.1787	.3677	2.5464	.3690	2.9154	.3704	3.2858	.3717	3.6575	.3730	60
62	2.1695	.3661	2.5356	.3675	2.9031	.3688	3.2719	.3700	3.6419	.3715	62
64	2.1604	.3646	2.5250	.3659	2.8909	.3672	3.2581	.3685	3.6266	.3698	64
66	2 1514	.3630	2.5144	.3644	2.8788	.3656	3.2444	.3669	3.6113	.3682	66
68	2.1424	.3616	2.5040	.3627	2.8667	.3641	3.2308	.3654	3.5962	.3666	68
70	2.1336	.3600	2.4936	.3613	2.8549	.3625	3.2174	.3638	3.5812	.3651	70
72	2.1248	.3585	2.4833	.3597	2.8430	.3610	3.2040	.3623	3.5663	.3636	72
74	2.1160	.3570	2.4730	.3583	2.8313	.3595	3.1908	.3608	3.5516	.3620	74
76	2.1074	.3555	2.4629	.3568	2.8197	.3580	3.1777	.3592	3.5369	.3605	76
78	2.0989	.3540	2.4529	.3552	2.8081	.3566	3.1647	.3577	3.5224	.3590	78
80	2.0903	.3526	2.4429	.3538	2.7967	.3551	3.1518	.3562	3.5080	.3575	80
82	2.0818	.3512	2.4330	.3524	2.7854	.3535	3.1389	.3548	3.4937	.3561	82
84	2.0735	.3497	2.4232	.3509	2.7741	.3522	3.1263	.3533	3.4796	.3545	84
86	2.0651	.3484	2.4135	.3495	2.7630	.3507	3.1137	.3518	3.4655	.3531	86
88	2.0569	.3469	2.4038	.3481	2.7519	.3493	3.1012	.3504	3.4516	.3514	88
90	2.0487	.3455	2.3942	.3467	2.7409	.3479	3.0888	.3490	3.4378	.3502	90
92	2.0406	.3441	2.3847	.3453	2.7300	.3465	3.0765	.3476	3.4241	.3488	92
94	2.0325	.3428	2.3753	.3439	2.7192	.3451	3.0643	.3462	3.4105	.3474	94
96	2.0246	.3414	2.3660	.3425	2.7085	.3437	3.0522	.3448	3.3970	.3460	96
98	2.0166	.3401	2.3567	.3411	2.6978	.3424	4.0402	.3434	3.3836	.3446	68
100	2.0088	.3387	2.3475	.3398	2.6873	.3409	3.0282	.3421	3.3703	.3432	100

TABLE B,

Giving the value of $\frac{100,000}{A_t}$ for various values of t, the value of A_t being $60345.51 \left\{ 1 + \frac{t-32}{450} \right\}$

Temperature.	$\frac{100,000}{A_t}$	Temperature.	$\frac{100,000}{A_t}$	Temperature.	$\frac{100,000}{A_t}$
—40°	1.972767	8°	1.750483	56°	1.573219
—38	1.962384	10	1.742303	58	1.566609
—36	1.952110	12	1.734200	60	1.560054
—34	1.941942	14	1.726171	62	1.553554
—32	1.931880	16	1.718216	64	1.547108
—30	1.921922	18	1.710335	66	1.540715
—28	1.912066	20	1.702525	68	1.534374
—26	1.902311	22	1.694786	70	1.528086
—24	1.892654	24	1.687117	72	1.521849
—22	1.883096	26	1.679518	74	1.515662
—20	1.873633	28	1.671986	76	1.509526
—18	1.864265	30	1.664522	78	1.503439
—16	1.854990	32	1.657124	80	1.497401
—14	1.845807	34	1.649792	82	1.491412
—12	1.836714	36	1.642524	84	1.485470
—10	1.827710	38	1.635320	86	1.479575
— 8	1.818795	40	1.628179	88	1.473727
— 6	1.809966	42	1.621100	90	1.467925
— 4	1.801222	44	1.614082	92	1.462168
— 2	1.792562	46	1.607125	94	1.456457
0	1.783985	48	1.600227	96	1.450790
2	1.775490	50	1.593389	98	1.445166
4	1.767075	52	1.586608	100	1.439587
6	1.758740	54	1.579885		

THE
AFFILIATION OF THE ALGONQUIN LANGUAGES.

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One of the modern schools of philologists has not heeded the scholastic maxim concerning *entia*, but has shown itself ready to multiply *origins* indefinitely without cause. Catlin, the artist, who, however, was very far from being a philologist, saw no necessity for showing how the Americans came to America, or that they ever came there at all. And at a conference on American subjects, held some three years ago, the President of the Anthropological Society of Paris found a warm reception for the statement, that the true solution of the question concerning the peopling of America is that the Americans are neither Hindoos, nor Phœnicians, nor Chinese, nor Europeans—they are Americans. An exception has been almost universally made in favour of the Esquimaux families of the far north, whose relations, physical and linguistic, with the Aleutan islanders and the Asiatic Tchuktchi are too striking to permit denial. In order to maintain the independent origin of the American tribes, it has been found necessary to deny the existence of any true likeness between the languages of the Old World and those of the New. The peculiar agglutination or synthetical character of American grammar, which, from the Athabascan area of the north to the Fuegian in the south, presents innumerable shades and broad lines of difference, has been represented as without parallel on the Eastern continent. Yet there are synthetic languages in Europe, Asia, Africa, Australia and the Islands of the Sea. At one time the Indo-European and Semitic grammars were the only systems compared with those of other families of speech. To these the Ural-Altaic, comprising the Ugrian of Europe and the Tartar-Mongolian of Asia, and the Monosyllabic, repre-

sented by the Chinese, have been added. But these do not exhaust the systems of the Eastern hemisphere. Wild as have been the statements made regarding the construction of languages, they have not equalled in folly the hasty utterances on the subject of their vocabularies. Messrs. Rivero and Tschudi, in their work on Peruvian Antiquities, write as follows: "The analogy so much relied on between the words of the American languages and those of the ancient continent have induced us to make an approximate estimate, *as far as our means would permit*, of the numerical value of the idioms of both hemispheres; and the result was that, from between eight and nine thousand American words, *one* only could be found analogous in sense and sound to a word of any idiom of the ancient continent." It is evident that these gentlemen, who deserve well for their services to ethnological science, never consulted even the imperfect lists of the Mithridates, and pursued their researches within such a narrow field as to falsify the doctrine of chances itself. Mr. Hubert H. Bancroft, to whom we owe a work of great value, "The Native Races of the Pacific States," allows himself to be led away to somewhat similar conclusions; but as he furnishes us with a list of so-called Darien numerals which are almost pure Gaelic, without noticing the phenomenon, it is to be presumed that, while a diligent and successful collector, Mr. Bancroft is no philologist.

Turning from philological to physical ethnology, we find that all the American families have been called Mongolian, and that nearly all attempts to affiliate the tribes of the Northern Continent have led inquirers to the Mongolian area in Eastern Asia. Even Dr. Latham, than whom there is no better authority on this subject, terms his large American class, American Mongolidæ. Yet, after stating that the Esquimaux are essentially Mongols, he adds: "On the other hand, in his most typical form, the American Indian is not Mongol in physiognomy. With the same black straight hair, he has an aquiline nose, a prominent profile, and a skin more red or copper-coloured than either yellow or brown. Putting this along with other marked characteristics, moral as well as physical, it is not surprising that the American should have been taken as the type and sample of a variety in contrast with the Mongolian."

It is not my intention in this paper to deal in a loose and general manner with the subject of American ethnology, but to confine myself to the connections of a single but large family of the aborigines of

the Northern Continent with the Old World. This is the extensive Algonquin family, reaching from Newfoundland to the Rocky Mountains, and from the Labrador Esquimaux and Hudson's Bay Athabascans to the Choctaw area in the Carolinas. Their collective name was Wapanachki, or *men of the east*, a term which still designates the Abenaki tribe of Maine. Their traditions universally refer to a migration from the far west, and the Great Spirit whom they worshipped had his home in no forest, prairie or lake, but on an island in the distant ocean. The principal tribe of this large family from the earliest period to which traditions refer was that of the Lenni Lenape, or Delawares. Closely allied to them in language are the Illinois, including the Miami, Piankashaws and other clans. The word Illinois, like the Lenni of Lenni Lenape, signifies *men*. The Shawnoes, who have been removed from Kentucky to the Western Reservation, speak a somewhat similar tongue, also using the word *ilenni* to designate *man*, but favouring the lisping *th* in place of the *s*, and cognate letters of other tribes. The Missisaguas, who originally, held the site of Toronto and the coast of Lake Ontario down to its outlet in the St. Lawrence, were likewise *linneeh*. North of these we find the Ojibbeway or Chippewa tribe, with whose name, appearance and language, Canadians are most familiar. They make a sparing use of the letter *l*, and term man *eneneh*, replacing that letter by *n*. The Crees, who call themselves *Nehethowuck*, and border on the Ojibbeways to the west of Lake Superior, thence spreading to the Esquimaux in the east and the Athabascans in the west, differ much among themselves in their pronunciation of certain liquids. The Athabascan Crees in the west turn the Lenape *l* into *r;* the Wood Crees, into *th;* the Hudson's Bay Crees, into *y;* the Plain Crees into *n;* while those of Labrador retain the Lenape form. At the same time the Cree has a tendency towards a species of alliteration in the same word, repeating the characteristic letter in place of the consonant which follows it. Thus the *ilenni* of the Illinois and Shawnoes becomes indeed *inenew* among the Plain Crees, *ithinew* among the Wood Crees, and *eyinew* among those of Hudson's Bay; but at Moose Factory it is *ililew*, and *eyiyew* on the East Main coast. Passing over the Nipissings, Ottawas and Algonquins proper, whose languages are closely allied and resemble more or less the Ojibbeway, we meet with the Micmacs of Nova Scotia, New Brunswick, &c., whose speech connects with the Lenape through the Abenaki, Etchemin,

Passamaquoddy and Penobscot of Maine. They also use the form *alnew* for man. Many extinct tribes, such as the Mohicans, Narragansets, Massachusetts, &c., once inhabited the New England States. Other tribes, like the Menomenies and Potawatomies, dwell south of Lakes Superior and Michigan in the Western States. Four tribes have lately been added to the Algonquin family. One of these, the Bethucks of Newfoundland, is extinct. The others are the Blackfoots on the Saskatchewan, extending west to the Rocky Mountains; and the Arrapahoes and Shyennes farther to the south. Dr. Latham has suggested a connection of the Blackfoot with the Hailtsa in the neighbourhood of Vancouver's Island, thus linking the Algonquin with the *Nas* languages of the Pacific coast. It is but a suggestion, however, and I have not been able to verify the connection. But there seem good reasons for finding Algonquin resemblances among the Sahaptin or Nez Percé tribes, whose habitat lies farther south on the same side of the Rocky Mountains, over against the Blackfoot and Shyenne country. Let this be established, and the Algonquin area extends across the whole continent from the east to the extreme west. To the Sahaptin relationship I make for the present no reference.

The Old World family of languages with which I have affiliated the Algonquin dialects is the Malay-Polynesian, a vast group extending from the Malayan peninsula to New Zealand, and from Madagascar to Easter Island. My vocabularies, while sufficiently extensive to indicate the relationship of the two families, are not sufficiently so to permit me to point out the particular divisions, Malay or Polynesian, Micronesian or Polynesian proper, with which the Algonquins coincide. Nor do I imagine for a moment that the Algonquins are the only American tribes whose course of migration is to be found in the line of Malay-Polynesian languages and influence. In the tables which accompany this paper I have taken a selection of words, thirty in all, representing nouns, adjectives and verbs, the most simple and characteristic, and thus least liable to suffer from foreign influences; and, grouping them according to their varying Algonquin forms, have compared them with analogous forms occurring within the Malay-Polynesian languages. They will be found to present such close and widespread resemblances as, I think, to render difficult the task of the objector. At the same time, the very partial representation of the Malay-Polynesian languages which my materials have enabled me to give, leads to the belief that, with a more extensive stock of

vocabularies, still more striking and definite results might have been obtained. To the thirty words above mentioned I have added the numerals of the Algonquin languages up to *ten*, similarly comparing them, but with results not quite so favourable. Still, even in this difficult field of comparison, important analogies appear. To exhibit the negative side of the argument, I have placed over against the Algonquin and Malay-Polynesian words the corresponding terms in the Asiatic and allied languages from which the American forms of speech might naturally be expected to take their derivation. Such are the Ugrian, Mongol, Tartar and Mantchu tongues, forming the Ural-Altaic class; the Samoied, Yenisei and Yukagir, conveniently termed Asiatic-Hyperborean; and the Japanese, Aino, Tchuktchi and Kamtschatdale, which are grouped as Peninsular. While a few analogies appear among some of these, their dissimilarity from the families under consideration is well worthy of attention. Here also I must confess that the imperfection of my lists, which are not selections, but contain all the material at present in my possession, hinders me from drawing too strict a line of demarcation. Lest it might be supposed that the analogy of the Algonquin with the Malay-Polynesian languages to which I have compared them is shared by other American families of speech, I have set forth the prevailing forms of the terms chosen for comparison in the Athabascan or Tinneh, the Wyandot-Iroquois, the Dacotah or Sioux, and the Choctaw classes, with all of which the Algonquin tongues are in geographical relation.

As far as my knowledge of the Malay-Polynesian languages extends, and it is very limited, I must admit that the striking lexical affinities are not borne out by equally close resemblances in the structure of language, as we compare for instance the grammar of the Algonquin with that of the Malays or of the Tonga islanders. There are, however, many widely differing grammatical forms among the large Oceanic class to which these belong. The Tagala spoken in the Philippine islands is, according to Dr. Latham, "essentially agglutinate in respect to its inflection;" and I must leave to those who are better versed in these tongues the task of comparing their agglutination with that of the Algonquin languages. While far from disparaging the value of grammatical forms in such connections as that under consideration, I am as far from believing in their permanence. Words are the bones of language, and we might as well take the whale and the bat out of the Mammalia as to separate tongues

using identical common terms on account of minor differences in grammatical combination. The resemblances between the Algonquin and the Malay-Polynesian vocabularies are the rule, not the exception; and on this ground I believe that an exhaustive analysis of the grammatical forms of the latter will yet exhibit at least a near approach to Algonquin structure.

In addition to the agglutination of the Tagala and kindred languages, a feature that appears more or less in all the Polynesian tongues, there are many points of resemblance as well as of difference between the Malay-Polynesian and the Algonquin. They agree in the absence of anything like true gender, and in the substitution for it of a distinction of nouns into animate and inanimate. The Algonquin languages, however, have a termination for the plural, while, as far as I am aware, the Malay-Polynesian mark plurality by a prefixed article or particle, or by the suffix of a numeral adjective. The Algonquin nouns have properly speaking no declension, and this is true of the Malay-Polynesian. But when case is marked in the latter, it is by forms of the article or by prefixed prepositions which frequently coalesce, while in the former the locative is denoted by a suffix. The genitive also precedes the nominative in Algonquin, but follows it in the Malay-Polynesian. The Malay-Polynesian languages have prepositions, and such are many of the Algonquin particles; but others are postpositions. This would seem, with other points of a similar character, to indicate the position of the Algonquin languages as one midway between the postponing Turanians of Asia and the preposing Malay-Polynesians. The Athabascans, Iroquois, Dacotahs and Choctaws, who surround the Algonquins on every side, all use postpositions, and their influence in this and other directions may have tended largely to render the Algonquin grammar somewhat Turanian. The substantive and the verb are but feebly distinguished in the two families under consideration, and in many cases not at all. In the formation of derivative nouns the Malay employs a prefix as well as an affix, and has been contrasted with the Algonquin, which makes use of the suffix only. Thus from Malay *tidor*, to sleep, comes *per-tidor-an*, a bed; while from Cree *nipow*, to sleep, is derived *nipawin*, a bed. The Polynesians do not follow the Malays in this respect, for the Tonga *mohe*, to sleep, gives us *mohenga*, a bed, in a form that is thoroughly Algonquin. In both families the adjective is invariable, but in the Malay-Polynesian its place is generally after the noun,

while in the Algonquin it generally precedes it. There are, however, suffix particles that take the place of adjectives in the latter class, and in most cases they are represented by verbs. The Malay-Polynesian adjectives are often hard to distinguish from substantives and verbs. The sign of comparison precedes the adjective in Algonquin, but follows in Tonga. But the accusative or object of the verb follows it in both Algonquin and Polynesian, and this separates them from the Turanian languages. Tense is designated by special marks in each case. These are Algonquin perfect *ki*, *gi*, future *ka*, *ga;* in Tonga present *gooa*, perfect *na*, future *te*. A larger acquaintance with Algonquin and Malay-Polynesian forms might reduce the differences between these. In the Tonga the index of tense is placed before the personal pronoun which precedes the verbal root, *e.g.*, makee, *give;* na-oo-makee, *I gave;* na-ger-makee, *thou gavest;* te-oo-makee, *I shall give;* te-ger-makee, *thou wilt give.* In Algonquin the temporal indices come between the pronoun and the verbal root, *e.g.*, makew, *give;* ni-ki-makew, *I gave;* ki-ki-makew, *thou gavest;* ni-ki-makew, *I shall give;* ki-ka-makew, *thou wilt give.* In spite of the difference in the order of pronoun and temporal index, the two classes agree in placing both these before the verbal root, thus entirely disagreeing with the Turanian languages in their Ural-Altaic and Dravidian divisions. The possessive pronoun or its equivalent precedes in the Algonquin, and either precedes or follows in the Malay-Polynesian languages. These languages also agree in dispensing with the relative pronoun. The forms of the demonstrative in Cree and Tonga are not unlike; Tonga, *this* aheni, *that* ahena; Cree, *this* anah, *that* naha. The same is true of the interrogative; Tonga ahai, coeha *who, which;* Cree awewe, kekway. The Polynesian languages have an article, and have on account of it been affiliated with the Bantu or Caffre languages of Southern Africa. Duponceau and other writers have insisted that the initial *M* of many Algonquin nouns, which generally precedes those that are not in a construct state, is the article. Others as firmly deny the statement, but have not accounted for the frequent dropping of this letter, *e.g.*, mistik, *a tree;* meyw-atik, *a good tree;* much-atik, *a bad tree; face*, mikwakun; *my face*, ni-kwakun. Undoubtedly there is some analogy here with the common Bantu prefixes *mo*, *ma*, *me*, and the Tagala article *ang*. The Caffre analogies, apart from language, with the Algonquins are striking. One important point of resemblance between the Algonquins and the Malay-Poly-

nesian is that both employ the pronoun of the first person plural in an inclusive and in an exclusive form:

Algonquin—ninawint, *they and I.*
kinawint, *you and I.*
Tonga—mow, gimowea, *they and I.*
tow, gitowea, *you and I.*

I may also add that both families of language have special terms to denote elder and younger brother, sister, &c. Such are the main points of agreement and diversity that have occurred to me, agreements which I think no more extended research can invalidate, and differences which, if not due to purely American influences derived from Northern Asia in the manner already indicated, may disappear in the progress of investigation. In any case the difficulties in the way of connecting the Malay-Polynesian and the Algonquin systems are far from insuperable. One important feature which the two classes possess in common, and by which they are distinguished from other families, Asiatic and American, is the absence of harsh sounds—the softness, which has been called the distinguishing characteristic of the Polynesian tongues, and which has attracted the attention of all who are in any way familiar with Algonquin speech.

I have not had time to investigate the relations subsisting between the manners, customs, superstitions, &c., of the Algonquins on the one hand and of the Malay-Polynesians on the other. Some of these, as tree worship, the use of totems and similar points, have been indicated by Sir John Lubbock. Dr. Pickering makes, I know not on what grounds, but doubtless for very satisfactory reasons, the following statement: "If any actual remnant of the Malay race exists in the eastern part of North America, it is probably to be looked for among the *Chippewas* and the Cherokees." The Chippewas or Ojibbeways are the Algonquins with whom it is likely the distinguished ethnologist was most familiar. The long black straight hair, the prominent features, the practice of depilation, and even the copper colour of the American Indian in general, are found in Polynesia; and the moral traits of the Algonquins find many analogies in the same region. The stage of culture attained by both peoples coincides. The maritime habits of the Malay-Polynesians have simply changed to the fluviatile and lacustrine in the Algonquin, while they serve to indicate the means by which the islander became the inhabitant of a continent. Dr. Pickering testifies with others to the long sea voyages

of many Polynesians, and thus designates the point at which such voyages might end on the American coast: "The Polynesian groups are everywhere separated from South America by a vast expanse of ocean, where rough waves and perpetually adverse winds and currents oppose access from the west. In attempting from any part of Polynesia to reach America, a canoe would naturally and almost necessarily be conveyed to the northern extreme of California; and this is the precise limit where the second physical race of men makes its appearance. So well understood is this course of navigation, that San Francisco, I am informed, is commonly regarded in Mexico as being on the route to Manilla."

Dr. Edkins, of Pekin, in "China's Place in Philology," says: "On the American continent, Turanian and Polynesian linguistic principles meet in the various Indian languages." And elsewhere he affirms that "we are warranted by linguistic data in concluding that there was a Polynesian immigration from the Ocean, and a Turanian immigration by the Aleutan Islands, and by Iceland and Greenland, which united to form the population of the American continent." Yet, like many other writers, Dr. Edkins seeks his Polynesians in Mexico and Peru, and would relegate the Algonquin origines to a Mongolian source.

Mr. Wallace, in his "Malay Archipelago," thus describes the peculiarities of Malay feature and character: "The colour of all these varied tribes is a light reddish brown, with more or less of an olive tinge, not varying in any important degree over an extent of country as large as all Southern Europe. The hair is equally constant, being invariably black and straight, and of a rather coarse texture, so that any lighter tint, or any wave or curl in it, is an almost certain proof of the admixture of some foreign blood. The face is nearly destitute of beard, and limbs are free from hair. The stature is tolerably equal, and is always considerably below that of the average European; the body is robust, the breast well developed, the feet small, thick and short, the hands small and rather delicate. The face is a little broad and inclined to be flat; the forehead is rather rounded, the brows low, the eyes black and very slightly oblique; the nose is rather small, not prominent, but straight and well shaped, the apex a little rounded, the nostrils broad and slightly exposed; the cheek bones are rather prominent, the mouth large, the lips broad and well cut, but not protruding, the chin round and well formed.

"In this description there seems little to object to on the score of beauty, and yet, on the whole, the Malays are certainly not handsome. In youth, however, they are often very good-looking, and many of the boys and girls up to twelve or fifteen years of age are very pleasing, and some have countenances which are in their way almost perfect. I am inclined to think they lose much of their good looks by bad habits and irregular living. At a very early age they chew betel and tobacco almost incessantly; they suffer much want and exposure in their fishing and other excursions; their lives are often passed in alternate starvation and feasting, idleness and excessive labour; and this naturally produces premature old age and harshness of features.

"In character the Malay is impassive. He exhibits a reserve, diffidence, and even bashfulness, which is in some degree attractive, and leads the observer to think that the ferocious and bloodthirsty character imputed to the race must be grossly exaggerated. He is not demonstrative. His feelings of surprise, admiration or fear are never openly manifested, and are probably not strongly felt. He is slow and deliberate in speech, and circuitous in introducing the subject he has come expressly to discuss. These are the main features of his moral nature, and exhibit themselves in every action of his life.

"Children and women are timid, and scream and run at the unexpected sight of a European. In the company of men they are silent, and are generally quiet and obedient. When alone the Malay is taciturn; he neither talks nor sings to himself. When several are paddling in a canoe, they occasionally chant a monotonous and plaintive song. He is cautious of giving offence to his equals. Practical joking is utterly repugnant to his disposition; for he is particularly sensitive to breaches of etiquette, or any interference with the personal liberty of himself or another. As an example, I may mention that I have often found it very difficult to get one Malay servant to waken another. He will call as loud as he can, but will hardly touch, much less shake, his comrade.

"The intellect of the Malay race seems rather deficient. They are incapable of anything beyond the simplest combination of ideas, and have little taste or energy for the acquirement of knowledge. Their civilization, such as it is, does not seem to be indigenous, as it is entirely confined to those nations who have been converted to the Mahometan or Brahminical religions."

There is hardly a single particular in all the above description which is not equally applicable to the Ojibbeway or any other member of the Algonquin family.

The precise form Lenni Lenape I have not yet met with in any Malay or Polynesian locality as a national or tribal designation, but the analogous forms Oran Benua, Oran Malaya, Oran Akkye, sufficiently shew whence the Delawares derived their title. The Javanese and Malagasy forms *lanan* and *ulun*, which take the place of the Malay *oran*, help to make the coincidence all but complete. As confirmatory evidence of the connection which I have established, I add comparisons of the personal pronouns and of a number of miscellaneous words in the two families related, comparisons which might be indefinitely extended.

The preparation of this paper having been made somewhat hurriedly in the midst of many other engagements, in order to bring the facts discovered as soon as possible before the Institute, I crave the indulgence of its members for unavoidable imperfections, trusting that the results obtained may not be without value to students of American antiquities and the science of comparative philology.

I.—COMPARATIVE VOCABULARY.

	Algonquin.	Malay-Polynesian.	Ural-Altaic.	Asiatic-Hyperborean.	Peninsular.
man,	lenno, linnon, *Del.*	lanan, *Java*; laki, *Mal.*	loman, *Mordwin*		el ku, *Kamtschatka*
husband	lenno, *Miami*	belane, *Gah* (Ceram)			
	linneeh, *Missisagua*	pulahan, *Wahai* (Ceram)			
	illini, *Illinois*	ulun, *Malagasy*	olona, *Lapp*		
	helaniah, *Miami*	umlanei, *Cajeli* (Bouru)	ulmo, *Tcheremiss*		
	netibelon, *Delaware*	malona, *Liang, Morella*	ellem-cholles, *Vogul*		
	ilenni, *Shawno*	*Lariki* (Amboyna)	sulahane, *Finn*		
	alnew, *Micmac*	belameranna, *Matabello*	nialma, *Mantchu*		
	illiew, *Cree*	lelah, *Baju*; lelay, *Malagasy*			
	renoes, *Sankikani*	oran, *Mal.*; arracat, *Pelew*	er, *Turk, Uigur*	eri, *Yenisei*	guru, *Kurile*
	irirew, irinew, *Cree*	roraki, *Bolanghitam* (Celebes)	erkhak, *Kasan*		
		remau, *Amblaw*	ere, *Mongol*	torömma, *Yukagir*	
	nemarough, *Virginia*	marnka, *Galela* (Gilolo)	murt, *Votiak*		
	weewarah, *Miami*	marauna, *Teor*	mari, *Tcheremiss*		
		maranauna, *Matabello*	feri, ember, *Magyar*		
		mori, *Wayapo* (Bouru)			
		burani, *Salayer* (Celebes)	tahe, *Ostiak*		
	ethini, *Cree*	tane, *Tahiti*	tungus, donki, *Tunguse*		hito, otoko, *Japanese*
	inini, *Algonquin, Nipissing*	omani, *Bouton* (Celebes)	ihminen, *Finn*		aino, *Aino*
	eyinew, *Cree*	ohana, *Tonga*	inimene, *Esthonian*	nienec, *Samoied*	momo, *Japanese*
	enainneew, *Menomeni*	anamhana, *Massaratty* (Bouru)	kumun, *Mongol, Kalmuk*	nganang, "	okkai, *Aino*
		anow, *Galela* (Gilolo)	kouhn, *Kalmuk*		oikyo, *Insu*
		emanow, *Amblaw*	kun, *Buriat*	oet, *Yenisei*	uika, *Tchuktchi*
	ninnow, *Blackfoot*	nonan, nau, *Tidore*	mies, *Finn*	hatket, "	chu; ikkega, *Loo Choo*
	nnin, *Narraganset*	man, *Mysol*		hadkip, "	
	neeah, *Potawatomi*	mon, *Gani* (Gilolo)		hlet, "	
	nah, *Shyenne*	manowa, *Saparua*		btet, "	
		manowai, *Awaiya* (Ceram)		ilset, "	
	naah, *Arrapaho*	manesh, *Sanguir* (Siau)			
		manusia, *Teluti* (Ceram)			
	enanitah, *Arrapaho*	mundai, *Batumerah* (Amboyna)		ennete, *Samoied*	
	mahtsee, muttuppe, *Blackfoot*	motu, *Mysol*; ndako, *Baju*			
		moudoo, *Tonga*			
	menapema, *Miami*	mondemapiu, *Gani* (Gilolo)			
	ninappem, *Cree*				
	ninabem, *Ojibbeway*				
	wechian, *Delaware*	wehoin, *Teor*	bey, *Tunguse*		
	weasia, *Shawno*	essah, *Salibabo*	kissoe, *Yakut*		
	tommawshew, *New England*	taumata, *Menado* (Celebes)	küschon, *Uigur*	hasawa, *Samoied*	
		tomata, *Salibabo*	kese, *Kirghis*	kase, "	
		tumata, *Saparua*	hage, chacha, *Mantchu*	yadu, *Yukagir*	
		tumata, *Ceram*	kassek, *Ostiak*		skoch, *Kamtschatka*

woman, wife	wusik, *Narragansett* wusukoh, *Natick* wewimow, *Cree*			wemiko, *Samoied*	uskuame, "
	wekemakun, *Cree* wecheakun, *Cree*	wowina, *Teor* bini, *Malay* bawine, *Bouton* (Celebes) babineh, *Salibabo* wadhon, *Java* pipina, *Saparua* fafine, *Tonga*, *Samoa* wahine, *Sandwich* wahine, *New Zealand* vahine, *Tahiti*	chatun, *Turk* avret, *Turk* chatuni, *Mongol*	pugutsa, *Samoied* pugica, *Samoied* bgim, *Yenisei*	
	weewan, *Ojibbeway* weewon, *Mohican*		chatuni, *Kalmuk* gergen, *Mongol* kadili, *Tartar* yaghtarim, *Yakut* feleseg, *Magyar* asszoni, "	byk hamalte, *Yenisei* alwaley, *Yukagir*	
	wiwah, *Piankashaw*	babayn, vahai, *Tagala* vaivave, *Malagasy* fofoya, *Tidore* bibo, *Bolanghitam* (Celebes) mahowent, *Sanguir* (Sian) mewina, *Teor* nilata, *Sula*	imi, ne, *Ostiak* ne, *Vogul* netacha, *Mordwin*	neu, naigum, *Samoied* nelgum, "	innago, *Loo Choo* meanako, *Insu* mennokoosi, *Aino* newem, *Tchuktchi* aganak, " nulliak, " taekki, *Loo Choo*
	neeweewah, *Miami* newah, *Shawno* neowoh, *Potawatomi* neeseewesok, *Penobscot* ahitaae, *Micmac* nongense, *Algonquin*	opedeka, mapideka, *Galela* mumabena, *Awaiya* mimabena, *Camarian* (Ceram) alehwa, *Matabello* gagijan, *Menado* (Celebes) fiyu, *Mysol*	akka, *Lapp* asi, akee, *Tungus* hegbe, cheche, *Mantchu* izi, *Mongol*		
	iskwee, *Algonquin* ochkeu, *Delaware* aque, *Ottawa* ichque, *Shawno* iekoe, *Illinois* acqnahique, *Nanticoke* kwyukih, *Sac & Fox* ahkeea, *Blackfoot* squaim, *Pampticoke* eskwa, *Cree* quaiwaw, *Shawno*	awwa *Sanguir* (Sian) sowom, *Cajeli* (Bouru)	kyschuo, *Finn*	tschutscha, *Samoied*	squaaw, *Kamtschatka*
child, infant (boy, son)	enese, *Narragansett* niechan, *Shawno* nitsch, *Delaware* negusis, *Algonquin* (boy) unquece, *Micmac* (boy) muckiese, *Narragansett* awansis, *Abenaki* abbenoojeeh, *Ojibbeway* awaunees, *Mohican* awasis, *Cree* pappoos, *Piankashaw*	anak, *Malay*, *Java*, *Tagala* *Salayer* (Celebes), *Sanguir* (Sian) anik, *Teor*; anako, *Bajau* anako, *Bolanghitam* (Celebes) anahei, *Saparua* ninna, *Liang* (Amboyna) wana, *Awaiya* (Ceram) wana, *Morella* (Amboyna) oanana, *Bouton* (Celebes) wai, *Mysol* fawha, *Tonga*	kichkinga, *Kasan* koakan, *Tungus* kootian, " uli, " deui, *Mantchu* (boy) koolron, *Mongol* oghlanjek, *Turk* hubegun, *Mongol* (boy) koeben, *Kalmuk* (boy) pi, *Siriaenian*, *Votiak* (boy) pojka, *Finn* (boy)	ngaceky, *Samoied* (boy) niama, " " nutschu, " esi, " lukoolu, *Yukagir* uwa, oua, *Yukagir*	iegnika, *Tchuktchi* (boy) rinaka, " " warrabee, *Loo Choo* kodoma, *Japanese* qua, *Loo Choo* vassasso, *Insu*

	MALAY-POLYNESIAN.	ALGONQUIN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
child, infant	papoos, *Narraganset*	bibigi, *Tonga*	pum, pu, py, *Vogul* (boy)	pup, *Yenisei*	
(boy, son)	pappouse, *New England*		pox, pax, *Ostiak* (boy)		
	peinses, *Natick*		fiu, *Magyar* (boy)	pijwo, *Yenisei* (boy)	pahatahitsh, *Kamtschatka*
	pokah, *Blackfoot*	pigineneh, *Salibabo*	uassum, *Vogul*		pec, paca, *Kamtschatka* (boy)
	memendid, *Delaware*	naanati, *Massaratty* (Bouru)	gyerek, *Magyar*	antou, *Yukagir* (boy)	
		nanat, *Wayapo* (Bouru)	gyermek, "		
	apilossah, *Miami*	opoliana, *Batumerah* (Amboyna)			
	hippelutha, *Shawno*				
	bobeloshin, *Ojibbeway*				
	necovis, *Souriquois* (boy)	ngofa, *Tidore*			
boy, son	negusis, *Cree, Algonquin*	anak, *Malay*	ogo, oal, *Yakut*	(see *child*)	(see *child*)
(*vocabularies*	nkos, *Passamaquoddy*	anak, *Malagasy*	ugli, *Turk*		
deficient)	nekeeah, *Menoment*	anak, *Tagala*	ol, oglan, *Tartar*		
	nekwessa, *Shawno*		dsui, *Mantchu*		
	neechaunis, *Missisagua*		hubegun, *Mongol*		
	ianis, *Ojibbeway*	zan, *Malagasy*	zon, *Sirianian*		
	naah, *Arrapaho*	zanac, "	csenk, *Magyar*		
	bawtoos, *Micmac*	budak, *Malay*	(see *child*)		
		butu, *Borneo*	parne, *Lapp*		
	quisos, *Delaware*		keschi, *Tcheremiss*		
	koisso, *Shawno*		koeben, *Kalmuk*		
girl, daughter	tahana, *Illinois*	tahine, *Tonga*	tytto, tytär, *Finn*	marchet, *Yukagir*	tacki, *Loo Choo*
(*vocabularies*	danis, *Delaware*		saatkan, *Tungus*	marhloo, "	
defective)	tanis, *Ottawa*				
	tanes, *Sac & Fox*				
	penumpun, *Massachusetts*	parumpuan, *Mal.* (woman)	ghoorkan, *Tunguse*		pannika, *Tchuktchi*
	panum, *Mohican*	penaulen, *Malay* "	leany, *Magyar*		
	phainem, *Powhattan*	ifneinin, *Alfuros* (Ceram) "			
	pehanum, *Penobscot*	binei, *Gah* (Ceram) "			
	po, *Abenaki*	vina, *Ahtiago* (Ceram) "			
	wosseeah, *Bethuck*	bibo, *Bolanghitam* (Celebes) "			
		baini, *Salayer* (Celebes) "			
		fina, *Sula* "			
		fineh, *Massaratty* (Bouru) "			
	tanetha, *Shawno*	dimlah, *Baju* "			
	mitanis, *Cree*	betina, *Malay* "			
	netawnah, *Miami*	wadhon, *Java* "	njejda, *Lapp*		
	netouche, *Souriquois*	moiyu, *Mysol* "		nädek, *Samoied*	
	nahteh, *Shyenne*			nitteng, "	
	naunais, *New England*	mainai, mahina, *Amboyna* "	non, *Mantchu*		
	neeshan, *Miami*	mewina, *Teor* "			ungua, *Loo Choo*
		mahoweni, *Sanguir* (Sian) "			sooguing, *Kamtschatka*
	epidek, *Micmac*	opideka, *Galela* "		baitaga, *Yukagir*	ucipek, "
	ahkeoquoin, *Blackfoot*		okin, *Kalmuk*	valendendi, "	komusime, *Japanese*

	iokwessen, *Algonquin*				musme, "
	squasese, *Narraganset*		kis, *Turk*		gogo, "
	ohkwisis, *Delaware*		kissim, keesa, *Yakut*		ohtshitshoo, *Kamtschatka*
head	wil, wile, *Delaware*	ulu, *Malay, Timor*	del, *Tunguse*	monoll, *Yukagir*	killa, *Kurile*
		Salayer, Camarian	tologai, *Mongol*	hollud, *Samoied*	
		ole, *Tupala*		kolka, *Yenisei*	
		hooloo, *Tonga*			
	wilan, *Shawno*	ilon, *Malagasy*			
		ulu, *Teor*			
		yulin, *Ahtiago*			
		olun, *Massaratty*			
		olum, *Cajeli*			
	weelekeh, *Shawno*	uruka, *Liang, Morella*			
		loho, *Malagasy*			
		aluda, *Matabello*			
	wiltustikan, *Minsi*	ulukatim, *Alfuros*			
	stikwan, *Cree*	katon, *New Zealand*			tchooma, *Kamtschatka*
	oshitigoine, *Algonquin*	katom, *Tawoo*			
	otokan, *Blackfoot*	kahutu, *Mysol*			
	wyer, *Sankikani*	uru, *Lariki, Saparua*			
		uru, *Bulanghitam*			
		kokore, *Timor*			
	puhkuk, *Massachusetts*	ourpoko, *New Zealand*	bash, *Turk*	eba, *Samoied*	bosi, *Loo Choo*
	pahihih, *Arrapaho*	ulaku, *Bouton*	bas, *Yakut*		kubi, *Japanese*
	bequequn, *New England*	poi, *Gani*	fej, *Magyar*	iok, *Yukagir*	
	uppaquontup, *Narraganset*		poenk, *Vogul*		
	upjpa, *Algonquin*		poe, poja, *Finn*		
	weensee, *Shawno*		oajve, *Lapp*		
	dup, utup, *Mohican*	tumbo, *Sanguir*			atama, *Japanese*
	neetup, *Penobscot*	timbonang, *Menado*	udjoo, *Mantchu*	tahig, *Yenisei*	kaahko, *Tchuktchi*
	lindepsekie, *Miami*				
	neppahkuk, *Natick*	nap, *Sula*			
	menengi, *Souriquois*	nangasahi, *Galela*		ngaewa, *Samoied*	naakok, *Tchuktchi*
	mononchi, *Micmac*				
mouth	matoon, *Penobscot*	moudoo, *Tonga*	awus, *Turk*	angda, *Samoied*	kandak, *Tchuktchi*
	muttoon, *Massachusetts*	motoo, *Mariannes*	ayach, *Yakut*	ak, aiwa, "	ekigin, "
	mattoon, *Nanticoke*	moda, *Tidore*	hamun, *Tunguse*	ngang, "	jeep, *Corea*
	maytone, *Menomeni*	motpo, *Mysol*	amga, "	nia, namo, "	cooche, *Loo Choo*
	mitoon, *Cree*	sumut, *Gani*	am, amma, *Mongol*	anga, *Yukagir*	kuzha, *Kamtschatka*
	namaltun, *Bethuck*	numatea, *Amblaw*	aman, "	khan, *Yenisei*	
		simud, *Malay*	umma, *Volga*	kohuj, "	
	indown, *Potawatomi*	gnootoo, *Tonga*	wom, *Lapp*		
	endounce, *Miami*	nhoutou, *Ticopia*	sma, *Tcheremiss*		
	nettee, *Arrapaho*		czad, szaj, *Magyar*		
	ootoun, *Abenaki*	vudin, *Ahtiago*	ayak, "		

	Algonquin.	Malay-Polynesian.	Ural-Altaic.	Asiatic-Hyperborean.	Peninsular.
mouth	otonn, *Mohican*		njalbme, *Esthonian*		
	wuttoon, *Narragansett*		oaiwe, *Lapp*		
	marthe, *Shyenne*	mulut, *Malay*			
	hetlee, *Arrapaho*	mouloo, "			
	meessey, *Ojibbeway*	nuku, *Saparua*			
	mahoi, *Blackfoot*	mangai, *New Zealand*			
		moboug, *Menado*			
		mohon, *Sanguir*			
		muen, *Waypo*			
		anoneu, *Massaratty*			
tongue	weelauloo, *Penobscot*	fleeloo, *Tonga*	kyle, *Kalmuk*	alup, *Yenisei*	
	nyllal, *Etchemin*	lelo, *Malagasy*	kelen, *Mongol*	alyap, "	
	wilano, *Delaware*	lilah, *Celebes, Sanguir*	kelli, *Finn*	siolo, *Samoied*	
	ouelane, *Miami*	leho, *Sandwich*	keli, *Esthonian*		
	weelinwee, *Shawnee*	wewelli, *Allor*	kil, *Permian*		
		ellah, *Sasak*			
		ewel, *Solor*			
		mella, *Ahtiago*			
		hilat, *Java*			
		alunto, *Celebes*			
		nangaladi, *Galela*			
	etalenee, *Cree*	dilah, *Celebes*	dil, *Turk*		nutshel, *Kamtschatka*
		dilah, *Tagala*			
		dila, *Bolanghitam*	till, *Yakut*		
		delah, *Bajo*			
	nirnon, *Souriquois*	aran, *Mysol*		suro, *Samoied*	
		arero, *Tahiti*		onnor, *Yukagir*	
		munartea, *Amblaw*			
	otaineni, *Ojibbeway*	tumoma, *Matabello*			
	tenanlan, *Ottawa*				
	ninanuh, *Mohican*	nimum, *Alfuros*	ingni, *Tungus*	njami, *Samoied*	chay, *Corea*
	meeaunob, *Natick*	neen, *Camarian*	enga, "	se, sie, "	stcha, *Loo Choo*
	neanum, *Nanticoke*	maanen, maan, *Bouru*	njuove, *Lapp*	andzhub, *Yukagir*	sita, *Japanese*
	minan, *Massachusetts*	man, *Timor*; maan, *Rotti*	njuokcam, *Lapp*		
	neunnaneweh, *Sac & Fox*	numawa, *Batumerah*	nych, *Magyar*		
	mitalune, *Cree*	mecolo, *Teluti*	nyelv, "		
	ooton, *Ojibbeway*	yeidi, *Gilolo*	nadam, *Ostiak*		
tooth, teeth	nibit, *Algonquin*	nifi, *Malagasy*			kuppet, *Kamtschatka*
	neebeet, *Abenaki, Micmac*	nifo, *Tonga, Tikopia*			
	nubidie, *Souriquois*	niphin, *Mariannes*	diah, *Turk*		ha, *Loo Choo*
	neepeetah, *Miami*	nifin, *Teor*	tees, *Yakut*		jea, *Japanese*
		nifan, *Ahtiago*	tish, *Tungus*		ji, *Corea*
	mepit, *Cree*	mopon, *Celebes*			gutuk, *Tchuktchi*
		nifoa, *Matabello*			watinka, "

	wipi, *Cree*	ifi, *Malagasy*	badne, *Lapp*		meemack, *Iuru*
	wipit, *Delaware*	afod, *Dani*	penk, *Ostiak*		
	wehit, *Potawatomi*	ipa, *Solor*			
	wyiyt, *Saukikani*	ipan, *Celebes*			
	weebeetah, *Penobscot*				
	veiaike, *Shyenne*	vessi, *Ombay*			
		waang, *Celebes*			
	nepitallah, *Shawno*	ungelell, *Pelew*			
		kal-ifin, *Mysol*		tody, *Yukagir*	
	tibbit, *Ojibbeway*		tibu, *Ostiak*	tiu, tiw, *Samoied*	
	tibit, *Algonquin*		tewa, "	tibbe, tim, "	
nose	yoch, *Ojibbeway*	iuka, *Morella*	ogot, *Tungus*		ko, *Corea*
	oochay, *Montang*	hihiou, *New Zealand*			
	oocheeush, *Menomeni*	ihoo, *Tonga*			
	yash, *Arrapaho*	issou, *Ticopia*			
	okissis, *Blackfoot*	ingok, *Bugis*			
	ohassio, *Shawno*				
	gheen, *Bethuck*	ijunga, *Bolanghitam*		ang, hang, *Yeniesi*	honna, *Loo Choo*
	kinnane, *Miami*	oanu, *Bouton*			ahynga, *Tchuktchi*
	akywan, *Saukikani*	nguno, *Galela*			kaankang, *Kamtschatka*
	okewon, *Mohican*	ngunu, *Sahoe*			
	nehichun, *Micmac*	sonina, *Gah*			
	chichkon, *Souriquois*				
	wuchaun, *Narraganset*	swanga, *Tawoo*			
	wikiwon, *Delaware*				
	oskiwin, *Cree*				
	ochengewane, *Algonquin*	hewonga, *Savu*			
	keeton, *Penobscot*	hidong, *Celebes*			
		hidoun, *Batchian*			
	matchamo, *New England*	idong, *Malay, Sasak*			
		Rotti, Celebes			
	mikoot, *Cree*	hengeato, *Celebes*			
	peechten, *New England*	panan, *Timor*		patsch, *Samoied*	fanna, *Japanese*
	ohalik, *Shawno*	gilinkaui, *Teor*		iogul, *Yukagir*	
	ochalie, "	shounggulu, *Mysol*		iongul, "	
		olicolo, *Teluti*	chabar, *Mongol*	olen, *Yeniesi*	
		ngilung, *Celebes*	aforo, *Mantchu*	oigen, "	
	ocrisis, *Blackfoot*	hiraka, *Liang*	orr, *Magyar*		
		ngerun, *Celebes*	mooron, *Yakut*		
		uroh, *Baju*	burun, *Turk*		
eye	miskisik, *Cree*	massou, *Malagasy*	silme, *Finn*		mi, mi, *Loo Choo*
	mishisisi, *Arrapaho*	missak, *Pelew* (see)	sialme, *Lapp*		liloegin, *Tchuktchi*
	neskque, *Miami*	matada, *Matabello*	calbme, "		lelengi, *Koriak*
	neskeesich, *Potawatomi*	matah, *Tagala*			
	maishkeisheik, *Menomeni*	madda, *Taguo*			

	Algonquin.	Malay-Polynesian.	Ural-Altaic.	Asiatic-Hyperborean.	Peninsular.
eye	mato, *Cree* (see, behold)	mata, *Malay*, &c., &c.	nitoun, *Mongol*	umat, *Yukagir* (see)	dun, *Corea*
	matoo, " (weep)	mato, *Java*	nidoun, *Kalmuk*		nanit, *Kamtschatka*
	schinquay, *Sankikani*	kanohi, *New Zealand*	szem, *Magyar*	sima, seme, *Samoied*	
	oskingick, *Ojibbeway*	tengo, *Malay* (see)	sem, *Ostiak*		
	kechekoue, *Miami*	tangi, *Tonga* (weep)	ujihu, *Mongol* (see)		kwatshquikotsh, *Kamt.* (see)
	nepiquigour, *Souriquois*		gueurmek, *Turk* (see)		netra, *Japanese*
	owepspec, *Blackfoot*		bakmak, " "		
	keesg, *Mohican*		gueuz, "	sai, saeu, *Samoied*	
	seesecko, *Penobscot*		kasak, *Yakut*	hai, "	
	wuskesuck, *Natick*		kus, *Uigur*	angszha, *Yukagir*	
	wuchkink, *Delaware*		kys, *Tartar*	dees, *Yenisei*	
	wuskink, *Mississagua*		jasza, *Mantchu*		
ear	otawagune, *Algonquin*	tayinga, *Tagala*	schan, "	ko, ku, *Samoied*	qui, *Corea*
	hadowugan, *Micmac*	tadigny, *Malagasy*	songsa, *Mongol* (hear)		eew, eewt, *Kamtschatka*
	touwango, *Penobscot*	taringa, *New Zealand*	kugach, *Yakut*		
	towakah, *Shawno*	talinga, *Malay*, &c., &c.			
	towohque, *Mohican*	dingher, *Mal.* (hear)			
	taouake, *Miami*	tenaan, *Mysol*			
	ottowug, *Ojibbeway*	tinacono, *Teluti*			
	wittawak, *Delaware*				
	wuttoowag, *Narraganset*				
	wehtough, *Massachusetts*				
	mitowukai, *Cree*				
	nootawee, *Abenaki*	motna, *Mysol*		oonomma, *Yukagir*	mime, *Japanese*
	mootchiman, *Bethuck*			kalogau, *Yenisei*	mime, *Loo Choo*
	hyttrwack, *Sankikani*	taria, *Tahiti*	korwa, *Finn*	kologan, "	mime, *Insu*
		turi, *Menado*	korot, *Tunguse*	klokan, "	
	chalksee, *Passamaquoddy*	codeelou, *Tavoo*	kulak, *Turk*	pil, *Samoied*	
		telekein-luni, *Alfuros*	fül, *Magyar*		
		toli, *Salayer*, *Sanguir*	pil, *Ostiak*		
		tigar, *Matabello*			
hand	oleechee, *Penobscot*	ala, *Awaiya*	el, *Turk*	ol, *Samoied*	tatlichka, *Tchuktchi*
	olatshi, *Shawno*	wuloba, *Tavoo*	gol, kol, *Tartar*		meejeeree, *Loo Choo*
	lichic, "	limaka, *Morella*	kol, *Uigur*		feejeeree, "
		yari, *Mal.*, *Java* (finger)	illi, *Yakut*		ki, "
		erike, *Baju* (finger)	gala, *Mantchu*		ti, *Japanese*
		ringa, *New Zealand*	gal, *Tunguse*		soan, *Corea*
	niligee, *Shawno*	ngalan, *Tagala*	gar, *Mongol*, *Kalmuk*		
		tanaraga, *Mangarei*	lagel, *Finn*		
	enahkee, *Miami*	inoa, *Sandwich*	lagol, *Ostiak*	nugan, *Yukagir*	
	nachk, *Delaware*	ingoa, *New Zealand*	kez, *Magyar*		
	nachk, *Sankikani*	hingoa, *Tonga*			
	oniskan, *Mohican*	outue, *Ombay*			
	michiche, *Cree*	angaro, *Malagasy*			myngitt, *Tchuktchi*

	wunnicheeke, *Narragansett*	dinga, *New Zealand*		tokan, *Yenisei* (finger)	
	neningeen, *Ojibbeway*	tangan, *Mal., Java, Bajo*		tok, " "	
	nenineh, *Potawatomi*	numonima, *Oak*			
	peton, *Micmac*	niman, *Ahtiago*			
to	mpateen, *Abenaki*	faban, *Wayapo*			settoo, *Kamtschatka*
		fahan, *Massaratty*			
	maharts, *Shyenne*	afonrima, *Tonga*			
		nimare, *Wahai*			
	maemed, *Bethuck*	motmor, *Mysol*			
		koumd, *Gani*			
		dumada, *Matabello*			
		limadu, *Sanguir* (finger)			
foot	kussie, *Shawno*	kaker, *Malay*	ajak, *Uigur*		asi, *Japanese*
	oaksakah, *Blackfoot*	aika, *Liang, Morella*			asi, *Loo Choo*
	kuut, *Micmac*	yohu, *Tidore*			tjuk, *Tchuktchi*
	katah, *Miami*	houta, *Malagasy*	attauch, *Yakut*		tchun-atchou, *Kamtschatka*
	syt, *Soukikani*	kadan, *Wayapo*			atschi, *Japanese*
	oxit, *Delaware*	eacto, *Malay* (leg)			talquatshoo, *Kamtschatka*
	seet, *Natick*				gitket, *Tchuktchi*
	seetuck, *Penobscot*				shanna, *Loo Choo*
	shooatchis, *Blackfoot*				
	waseed, *Delaware*	wed, *Gani*			
	wusete, *Narragansett*	oweda, *Matabello*			
	misit, *Cree*	tombut, *Malagasy*			
		afoaivae, *Tonga*			
	nauthauitah, *Arrapaho*	matwey, *Mysol*			
	nechahtei, *Miami*	mukalata, *Ombay*		nghe, *Samoied*	
	nesit, *Potawatomi*	nandohu, *Gaiela*			
	nesittun, *Ojibbeway*	ungoor, *Malagasy*			
	lekekisitan, *Cree* (toes)	tofatunga, "	boodal, *Tungus*	noel, *Yukagir*	
		ltimen, *Massaratty*	kul, *Mongol*		
black	kusketa, *Cree*	bitim, *Cajeli*	lab, *Magyar*		
	suckesa, *Narragansett*	kokotu, *Tidore*	siah, *Turk*	saga, seak, *Samoied*	dochmu, *Kamtschatka*
	shikayo, *Long Island*	kokotu, *Ternate*	kara, "	hay, "	tanjachtin, *Tchuktchi*
	sicksoh, *Potawatomi*	kokotu, *Sahoe*	chara, *Yakut*	sagar, "	kunni, *Aino*
	suckgek, *Delaware*	kitkudu, *Gani*	kara, *Tungus*		kuroi, *Japanese*
	skayuatsee, *Blackfoot*	kuda, *Kaioa*	fahala, *Mantchu*		korosa, *Loo Choo*
	kuketa, *Cree*	kasa, *Pelew*	behe, *Mongol*		
	nsikkayoah, *Mohican*	kamdichei, *Amblaw*	hara, kura, *Mongol*		
	mooi, *Massachusetts*	ngeo, *Rotti*	fekete, *Magyar*		
	mowesu, *Narragansett*	ngoa, *Batchian*	cap, *Lapp*		
	mokkum, *Algonquin*	paisim, *Dorey*		newai, *Samoied*	mowukain, *Koriak*
		moitomo, *Bolanghitam*		smaakua, *Samoied*	
		maitum, *Sanguir*		aimaivi, *Yukagir*	

	ALGONQUIN.	MALAY-POLYNESIAN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
black	mukuta, *Cree*	moito, *Celebes*	musta, *Finn*	emmitah, *Yukagir*	
	mukkudaiwah, *Ojibbeway*	muhonde, *Celebes*			
	mackatay, *Ottawa*	mahitum, maitang, *Celebes*			
	mahkateoqquinque, *Miami*	memetan, *Ahtiago*			
	mukkoote, *Shawno*	malotong, *Bugis* (Celebes)			
	mandzey, *Bethuck*	meteh, *Saparua*			
		meddi, *Savu*			
		mete, *Liang*, *Morella*, &c.			
		maita, *Salibabo*			
white	opee, *Shawno*	boo, bus, *Mysol*	ak, *Turk*	jallena, *Samoied*	siro, *Japanese*
	opeh, *Minsi*	kebo, *Macassar*	irungk, *Yakut*	poinnei, *Yukagir*	sheeroosa, *Loo Choo*
	wabi, *Algonquin*	babut, *Ahtiago*	shaygan, *Mantchu*		attagho, *Kamtschatka*
	wobee, *Bethuck*	bobudo, *Ternate*	shangien, "		katulje, *Tchuktchi*
	wape, *Delaware*	piuper, *Dorey*	geltadi, *Tunguse*		kachtschuktuk, *Tchuktchi*
	wapisew, *Cree*	boti, *Bouru*, *Sula*	chagan, *Mongol*		
	wawbisse, *Ojibbeway*	potih, *Baju*	zagan, "		
	wabeek, *Micmac*	putih, *Malay*, *Ceram*,	walkia, *Finn*		
	wapiyo, *Passamaquoddy*	*Amboyna*	welkes, *Lapp*		
	waupaeek, *Mohican*	pudi, *Sam*	vielgad, "		
	wauppauyu, *Nanticoke*	budo, *Sahoe*	feyer, *Magyar*		
	wapeskaya, *Sac & Fox*	maputi, *Bouton*			
	wapekingeek, *Miami*	mabida, *Menado*			
	wompi, *Massachusetts*	umpoti, *Cajeli*			
	wampi, *Natick*	mopotiho, *Bolanghitam*			
	wanbegan, *Abenaki*	maphuti, *Matabello*			
	wompesu, *Narraganset*	maphutu, *Gah*			
red (blood)	squayo, *Long Island*	kao, *Liang*, *Morella*	kisil, *Tartar*	kelenni, *Yukagir*	akassa, *Loo Choo*
		Saparua, *Camarian*, *Teluti*	kasil, *Yakut*		tahaang, *Kamtschatka*
		shei, *Mysol*	kirmizi, *Turk*		
	ahsain, *Blackfoot*	hashuatea, *Amblaw* (blood)	fulg, *Mantchu*		
	mik, miskoosew, *Cree*	mia, *Sula*	koolani, *Tunguse*		
	mahe, *Shyenne* (blood)	miha, *Massaratty*	ruopses, *Lapp*		
	mesquah, *Ojibbeway*	miba, *Wayapo*	veres, *Magyar*		
	misqueh, *Massachusetts*	mecoit, *Gani*	wyry, *Ostiak*		
	mescone, *Algonquin*	mehani, *Amblaw*			
	mokum, *Delaware* (blood)	mahamu, *Menado*			
	mohisenum, *Blackfoot*	mosina, *Wahai*			
	mainkhe, *Menoment* (blood)	mame, *Mysol*			
	nihpeekanneh, *Miami* "	mopoha, *Bolanghitam*			
	babe, *Arrapaho* "	poha, *Sula* (blood)			
	bagakkan, *Abenaki* "	abaug, *Java*	puna, *Finn*		
	pocaghkan, *Mohican* "				
	pocagnu, *Passamaquoddy* "				
	puckeuckque, *Nanticoke* "				

bad	mattik, *Nanticoke* myatesh, *Cree* machinnew, *Cree* munnadud, *Ojibbeway* makhtitton, *Delaware* motchie, *Shawno* matchit, *Mohegan* mudji, *Ojibbeway* matchi, *Miami* matche, *Ottawa* malatisew, *Cree* maratisew, " matoualkr, *Micmac* pahkaps, *Blackfoot*	maduki, *Bouton* molain, *Bolanghitam* mogasaki, *Bissayan* maunget, *Pelew* masama, *Tagala* nakie, *Cajeli* lahat, *Malay* jahat, " aluati, *Wahai* avet, *Ahtiago* mungalotuck, *Gah* maraut, *Bissayan* megull, *Pelew* mugkasalla, *Bissayan* behei, *Amblaw* boussooe, *Malay*	muchai, *Buriat* mou, adu, *Kalmuk* maeho, *Mongol* eche, mpt, *Mantchu* kaulult, *Lamute* elang, " fena, *Turk* jaman, " scher, " geman, *Tartar* pis, *Kirghis* kuttir, *Yakut* wika, *Finn* wikke, *Lapp* baj, *Magyar* paha, *Finn, Lapp*	buschtenga, *Samoied* bilu, " erritah, *Yukagir* ——— kurjast, *Esthonian* losogod, *Ostiak* rosz, *Magyar* gonosz, " kul, *Vogul* booktahalran, *Tungus*	neesha, *Loo Choo* wasa, " kiwo, *Japanese* warri, " warikakure, *Japanese* faradato, " khatkin, *Koriak* guetkin, *Tchuktchi* guerkin, " adkang, *Kamtschatka*
good	wulillisiwi, *Delaware* meloo, *Cree* galosit, *Micmac*	weel, *Pelew* aolo, *Awaiya* alla, *Baju* laha, *Tidore* lilia, *Tonga* lelei, *Samoa* maholi, *Sanguir* malopi, *Separua* taloha, *Galela* paret, *Amblaw* marope, *Bouton* mai, *Lariki, Camarian* maikai, *Sandwich* mapuya, *Saliaba* maitai, *Tagala, Austral.* metoki, *Mariannas* mitaki, *Rarotonga* ko-mala, *Ahtiago* ungano, *Cajeli* sabelle, *Menado* elda, *Tonga* dagosa, *Wayapo* dagosa, *Massaratty* amaiat, *Batumerah* tabai, baik, *Malay* butje, *Java* baji, *Salayer*	iol, *Magyar* ariooldooln, *Tungus*	——— nanitallitah, *Yukagir*	
	ouret, *Sankikani* meroo, *Cree* meyoo, *Cree* mino, *Algonquin*			tauritah, *Yukagir*	kurassa, *Loo Choo*
	mithoo, *Cree*		ttugai, *Yakut*		matschinka, *Tchuktchi* hota, *Corea*
	onishishin, *Nipissing* oonesheeshing, *Ojibbeway* hacksaw, *Blackfoot* aghsee, "		sain, *Mongol* ssain, *Mantchu* ayi, *Turk* jo, *Magyar*		jukka, *Japanese*
	owaisaw, *Shawno*				
great, large	kiche, *Cree*	alyuk, *Ahtiago*	jajkai, *Kalmuk*	agga, *Samoied*	ikai, *Japanese*

	ALGONQUIN.	MALAY-POLYNESIAN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
great, large	gitche, *Ojibbeway*	gede, *Java*	ekraham, *Tunguse*		okii, *Japanese*
		haat, *Massaratty*	kookas, *Finn*		kaaguk, *Tchuktchi*
	missi, *Shawno*	naiki, naaik, *Timor*	magas, *Magyar*		
	meesha, *Algonquin*	monghi, *Bouton*	nagy, "	tahomoi, *Yukagir*	
	ohmohco, *Blackfoot*	wanko, *Celebes*			
	makauk, *Mohican*	owhosi, "	amba, *Mantchu*	paca, *Yeniset*	weesa, *Loo Choo*
		bobuk, *Gah*	boyuk, *Turk*	birkha, "	
		bakeh, *Salayer*		pirce, "	
		moneai, *Saru*			
		maina, *Wahai*			
	ispisew, *Cree* (high)	bagewa, *Salibabo*			
	misikiti, *Cree*	bagut, *Wayapo*			
		maata, *Raratonga*			
		matua, *Rotti*			
		enda, *Batumerah*			
	innuya, *Blackfoot* (long)	jinny, *Arru*			
		nui, *Tahiti*, *Sandwich*			
		Mariannes, *New Zealand*			
	machkilk, *Micmac*	musolab, *Celebes*	azimilahan, *Turk*		
		morokaro, *Bolanghitam*	oolachan, *Yakut*		
		oleeakerk, *Pelew* (high)			
small	chuckie, *Shawno*	chi, igi, oohigi, *Tonga*	kuchuk, *Turk*		ko, *Japanese*
	sahkee, *Blackfoot* (short)	koi, *Cajeli*, *Liang*, *Lariki*			kusa, *Loo Choo*
		kickaray, *Pelew*			
	aguchin, *Algonquin*	kokaueli, *Camarian*	kichkinga, *Kasan*	kisigena, *Yeniset*	ucinan, *Kamtschatka*
		kichil, *Malay*	ukka, *Lapp*	khennenam, *Yeniset*	komaka, *Japanese*
	ehimasin, *Cree* (short)	keni, *Tidore*	isi, *Tcheremiss*	kanok, *Samoied*	ucinolo, *Kamtschatka*
		gunam, *Mysol*			
	takoosew, *Cree* (short)	decheki, *Galela*			
		didiki, *Baju*	unna, *Lapp*		
	enahcootsie, *Blackfoot*	ngiti, *Raratonga*	kutshugai, *Yakut*	ngoliu, *Samoied*	
	langtitti, *Delaware*	nuto, *Sandwich*	nukishookan, *Tunguse*	lukun, *Yukagir*	liuchiu, *Koriak*
		ahuntai, *Morella*	madshige, *Mantchu*	tanu, *Samoied*	ekitachtu, *Tchuktchi*
		titti, *Samoa*	tytto, *Finn*		
		kadodo, *Salibabo*	kistin, *Magyar*		
		kidikidi, *Bouton*	kicsiny, "		
		kutti, *Wahai*	icet, *Permian*		
	upisee, *Cree*	fek, *Teor*	baga, bacha, *Mongol*		
	abissahew, *Ojibbeway*	wotawota, *Gah*	waha, *Finn*		
		walwalo, *Gani*			
		bakoti, *Amblaw*			
	pistakwin, *Blackfoot*	pindeck, *Malay*			
	punge, *Ojibbeway*	bougnia, "			
some	pache, *Cree*	paituco, *Baju*	guel, *Turk*	(*defective*)	kuru, *Japanese*

	pahsaha, *Ojibbeway* pitteauimum, *Algonquin* pokhasapitl, *Blackfoot* pasatan, *Cree* astamotoh, *Cree*	bomun, *Mysol* buoma, *Amblaw*	iraku, *Kalmuk* lähestyn, *Finn* toole, *Tcheremiss* tule, *Ostiak*		arkee, *Inu*
	ondjipi, *Nipissing* tootoo, *Blackfoot* tukoosin, *Cree* wigun, *Micmac* ome, *Shawno*	tomaymal, *Sandwich* dumahl, *Sanguir* matka, *Salayer* mapa, *Tagala* aimepu, *Menado* maive, *Bouton* datan, *Malay* tae, *Tahiti* ikomai, *Wayapo* jogmah, *Mysol* gumahi, *Massaratty* omai, *Cajeli*, *Batumerah* hammamai, *Marquesas* hoemy, *Sandwich* uimai, *Liang* mai, *Sula*, *Gani*, *Teluti*, *Gah*, *Wahai*, &c., &c.	tachi, *Mantchu* daime, " tusaim, *Mongol* joni, *Magyar* uini, *Votiak*		hoqnasitch, *Kamtschatka* chung, *Loo Choo*
go	ache, *Cree* aji, *Algonquin* mahjod, *Ojibbeway* machow, *Cree* madji, *Nipissing* waipthai, *Shawno* aimyet, *Micmac* kitootao, *Cree*	uko, *Ahtiago* iko, *Wayapo* wiki, *Massaratty* jog, *Mysol* ai, *Saparua* hoe, *Sandwich* maku, *Menado* mutugi, *Gobela* buuh, *Amblaw* wo, *Tonga* bo, *Mysol* owelo, *Cajeli* mapurotoh, *Salibabo* lampa, *Salayer* lipatau, *Bouton* lungo, *Java* kotango, *Gah* taha, *Gani* tetak, *Alfuros* itai, *Teluti*	jangam, *Ostiak* magy, *Magyar* menni, " yabu, *Mongol* bar, *Yakut* choorii, *Tungus* guitmek, *Turk*	(defective) ingborgbodak, *Yukager*	yuki, *Japanese* kung-chung, *Loo Choo* howisitch, *Kamtschatka*
eat (*vocabularies defective*)	mechew, mechisoo, *Cree* wisin, *Algonquin* mennisi, *Arrapaho* mitishin, *Menomeni*	makou, *Malay* munga, *Pelew* amu, *Tahiti*	emmi, *Magyar*		

I.—COMPARATIVE VOCABULARY.

	ALGONQUIN.	MALAY-POLYNESIAN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
man,	lenno, linnon, *Del.*	lanan, *Java*; laki, *Mal.*	loman, *Mordwin*		el ku, *Kamischatka*
husband	lenno, *Miami*	belano, *Gah* (Ceram)			
	linnech, *Mississagua*	pulahan, *Wahai* (Ceram)			
	ilini, *Illinois*	ulun, *Malagasy*	olona, *Lapp*		
	helaniah, *Miami*	umlanei, *Cajeli* (Bouru)	ulmo, *Tcheremiss*		
	netthelon, *Delaware*	malona, *Liang*, *Morella*	ellem-chollen, *Vogul*		
	llenni, *Shawno*	*Loriki* (Amboyna)	sulahane, *Finn*		
	alnew, *Micmac*	helameranna, *Matabello*	nialma, *Mantchu*		
	lillew, *Cree*	lelah, *Baju*; lelay, *Malagasy*			
	renoes, *Sankikani*	oran, *Mal.*; arraeat, *Pelew*	er, *Turk*, *Uigur*	eri, *Yenisei*	guru, *Kurile*
	irinow, irinow, *Cree*	toraki, *Bolaughitam* (Celebes)	erkhak, *Kasan*		
		roman, *Ambiaw*	ere, *Mongol*	tordmma, *Yukagir*	
	nemarough, *Virginia*	maroka, *Galela* (Gilolo)	murt, *Votiak*		
	weewarah, *Miami*	marunna, *Teor*	mari, *Tcheremiss*		
		marananna, *Matabello*	feri, ember, *Magyar*		
		mori, *Wayapo* (Bouru)			
		burnoi, *Salayer* (Celebes)	taho, *Ostiak*		
	ethini, *Cree*	tane, *Tahiti*	tungus, donki, *Tunguse*		hito, otoko, *Japanese*
	inini, *Algonquin*, *Nipissing*	omnai, *Bouton* (Celebes)	ihminen, *Finn*		aino, *Aino*
	eyinew, *Cree*	ohana, *Tonga*	inimene, *Esthonian*	nienec, *Samoied*	momo, *Japanese*
	enainneew, *Menomeni*	anamhana, *Massaratty* (Bouru)	kumun, *Mongol*, *Kalmuk*	ngaänang, "	okkai, *Aino*
		anow, *Galela* (Gilolo)	kouhn, *Kalmuk*		oikyo, *Insu*
		emanow, *Ambiaw*	kun, *Buriat*	cet, *Yenisei*	uika, *Tchuktchi*
	ninnow, *Blackfoot*	nouan, nau, *Tidore*	mies, *Finn*	hatket, "	chu, ikkega, *Loo Choo*
	nnin, *Narraganset*	man, *Mysol*		hadkip, "	
	neeah, *Potawatomi*	mon, *Gani* (Gilolo)		hlet, "	
	nah, *Shyenne*	manowa, *Saparua*		btet, "	
		manowai, *Awaiya* (Ceram)		fiset, "	
	naah, *Arrapaho*	maneah, *Sanguir* (Siau)			
		manusia, *Teluti* (Ceram)			
	enanitah, *Arrapaho*	mundai, *Batumerah* (Amboyna)		ennete, *Samoied*	
	mahtsee, muttuppe, *Blackfoot*	motu, *Mysol*; udako, *Baju*			
		moudoo, *Tonga*			
	menapema, *Miami*	mondemapin, *Gani* (Gilolo)			
	ninappem, *Cree*				
	ninabem, *Ojibbeway*				
	wechlan, *Delaware*	wahoin, *Teor*	bey, *Tunguse*		
	wessia, *Shawno*	essah, *Salibabo*	kissoe, *Yakut*		
	tommawshow, *New England*	taumata, *Menado* (Celebes)	küschon, *Uigur*	hasswa, *Samoied*	
		tomata, *Salibabo*	kese, *Kirghis*	kasa, "	
		tumata, *Saparua*	hage, chacha, *Mantchu*	yadu, *Yukagir*	
		tumata, *Ceram*	kassek, *Ostiak*		skoch, *Kamtschatka*

woman, wife	wauik, *Narragansett* wasukeh, *Natick* wowimow, *Cree* wekemakun, *Cree* wecheakun, *Cree* weewan, *Ojibbeway* weewon, *Mohican* wiwah, *Piankashaw* neeweewah, *Miami* newah, *Shawno* neowoh, *Potawatomi* neeseeweeok, *Penobscot* ab'itase, *Micmac* nongense, *Algonquin* ickwee, *Algonquin* ochkeu, *Delaware* aque, *Ottawa* ichque, *Shawno* iekoe, *Illinois* acquahique, *Nanticoke* kwyokib, *Sac & Fox* ahkeea, *Blackfoot* aqnaha, *Pamptieoke* eskwa, *Cree* quaiwaw, *Shawno*	wewina, *Teor* bint, *Malay* bawine, *Bouton* (Celebes) babineh, *Salibabo* waibon, *Java* pipina, *Saparua* fafine, *Tonga*, *Samoa* wahine, *Sandwich* wahine, *New Zealand* vahine, *Tahiti* babaye, vabai, *Tagala* vatvave, *Malagasy* fofoya, *Tidore* bibo, *Bolanghitam* (Celebes) mahoweni, *Sanguir* (Sian) mewina, *Teor* nifata, *Sula* opodeka, mapideka, *Galela* mumahena, *Awaiya* rimahena, *Camarian* (Ceram) ahehwa, *Matabello* gagijan, *Menado* (Celebes) jiyu, *Mysol* sawa *Sanguir* (Sian) sowom, *Cajeli* (Bouru)	chatun, *Turk* avret, *Turk* chatuni, *Mongol* chatuni, *Kalmuk* geregen, *Mongol* kadil, *Tartar* yaghtarim, *Yakut* feleseg, *Magyar* aszoni, " imi, ne, *Ostiak* ne, *Vogul* netacha, *Mordwin* akka, *Lapp* asi, akee, *Tungus* heghe, cheche, *Mantchu* izi, *Mongol* kyschuo, *Finn*	wemako, *Samoied* pugutsa, *Samoied* pugica, *Samoied* bgim, *Yenisei* byk hamalte, *Yenisei* alwaley, *Yukagir* neu, naigum, *Samoied* nelgum, " tschutscha, *Samoied*	uskumu; " innago, *Loo Choo* meanako, *Insu* mennokoosi, *Aino* newem, *Tchuktchi* aganak, " nulliak, " taekki, *Loo Choo* squaaw, *Kamtschatka*
child, infant (boy, son)	enese, *Narragansett* mechan, *Shawno* nitseh, *Delaware* negusis, *Algonquin* (boy) unquece, *Micmac* (boy) muckiese, *Narragansett* awausis, *Abenaki* uhbenoojeeh, *Ojibbeway* awaunsees, *Mohican* owasis, *Cree* pappoos, *Piankashaw*	anak, *Malay*, *Java*, *Tagala* *Salayer* (Celebes), *Sanguir* (Sian) anik, *Teor*; anako, *Baju* anako, *Bolanghitam* (Celebes) anahei, *Saparua* niana, *Liang* (Amboyna) wana, *Awaiya* (Ceram) wana, *Morella* (Amboyna) oanana, *Bouton* (Celebes) wai, *Mysol* fawha, *Tonga*	kichkinga, *Kasan* koakan, *Tunguse* kootlan, " uil, " daui, *Mantchu* (boy) koolron, *Mongol* oghlanjek, *Turk* hubegun, *Mongol* (boy) koeben, *Kalmuk* (boy) pi, *Sirianian*, *Votiak* (boy) pojka, *Finn* (boy)	ngacoky, *Samoied* (boy) niama, " " nutschu, " esi, " lukoolu, *Yukagir* uwa, oua, *Yukagir*	iegnika, *Tchuktchi* (boy) rinaka, " " warrabee, *Loo Choo* kodoma, *Japanese* qua, *Loo Choo* vassasso, *Insu*

	MALAY-POLYNESIAN.	ALGONQUIN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
child, infant	papoos, *Narraganset*	bibigi, *Tonga*	pum, pu, py, *Vogul* (boy)	pup, *Yenisei*	
(boy, son)	pappouse, *New England*		pox, pax, *Ostiak* (boy)		
	peisses, *Natick*		fiu, *Magyar* (boy)	pijwo, *Yenisei* (boy)	pahatshitsh, *Kamtschatka*
	pokah, *Blackfoot*	pigineneh, *Salibabo*	uassum, *Vogul*		pec, paca, *Kamtschatka* (boy)
	memendid, *Delaware*	naanati, *Massaratty* (Bouru)	gyerek, *Magyar*	antou, *Yukagir* (boy)	
		nanat, *Wayapo* (Bouru)	gyermek, "		
	apiloosah, *Miami*	opoliana, *Batumerah* (Amboyna)			
	hippelutha, *Shawno*				
	bobeloshin, *Ojibbeway*				
	necovis, *Souriquois* (boy)	ngofa, *Tidore*			
boy, son	negusis, *Cree, Algonquin*	anak, *Malay*	ogo, oal, *Yakut*	(see *child*)	(see *child*)
(*vocabularies*	nkos, *Passamaquoddy*	anak, *Malagasy*	ugil, *Turk*		
deficient)	nekeesh, *Menomeni*	anak, *Tagala*	ol, oglan, *Tartar*		
	nekwessa, *Shawno*		dsui, *Mantchu*		
	neechaunis, *Mississagua*		hubegun, *Mongol*		
	ianis, *Ojibbeway*	zan, *Malagasy*	zon, *Sirianian*		
	naah, *Arrapaho*	zanac, "	czenk, *Magyar*		
	bawtoos, *Micmac*	budak, *Malay*	(see *child*)		
		butu, *Borneo*	parne, *Lapp*		
	quisses, *Delaware*		keschi, *Tscheremiss*		
	koisso, *Shawno*		koeben, *Kalmuk*		
girl, daughter	tahana, *Illinois*	tahine, *Tonga*	tytto, tytär, *Finn*	marchet, *Yukagir*	tacki, *Loo Choo*
(*vocabularies*	danis, *Delaware*		asatkan, *Tunguse*	marhloo, "	
defective)	tanis, *Ottawa*				
	tanes, *Sac & Fox*				
	penumpun, *Massachusetts*	parumpuan, *Mal.* (woman)	ghoorkan, *Tunguse*		pannika, *Tchuktchi*
	panum, *Mohican*	peusulen, *Malay* "	leany, *Magyar*		
	phainem, *Powhattan*	ifnefnin, *Alfuros* (Ceram) "			
	pehanum, *Penobscot*	binei, *Gah* (Ceram) "			
	po, *Abenaki*	vina, *Ahtiago* (Ceram) "			
	wonaseeah, *Bethuck*	bibo, *Bolanghitam* (Celebes) "			
		baini, *Salayer* (Celebes) "			
		fina, *Sula* "			
		fineh, *Massaratty* (Bouru) "			
	tanetha, *Shawno*	dindah, *Baju* "			
	mitanis, *Cree*	betina, *Malay* "			
	netawnah, *Miami*	wadhon, *Java* "	njejda, *Lapp*		
	netouche, *Souriquois*	motyu, *Mysol* "		nädek, *Samoied*	
	nahteh, *Shyenne*			nitteng, "	
	naunais, *New England*	mainai, mahina, *Amboyna* "	non, *Mantchu*		
	neeshan, *Miami*	mewina, *Teor* "			ungua, *Loo Choo*
		mahoweni, *Sanguir* (Sian) "			soogning, *Kamtschatka*
	epidek, *Micmac*	opideka, *Galela* "		baitaga, *Yukagir*	ucipek, "
	ahkeoquoin, *Blackfoot*		okin, *Kalmuk*	valendendi, "	komusime, *Japanese*

head	iokwessen, *Algonquin* squasese, *Narragansett* ohkwisis, *Delaware* wil, wile, *Delaware*	ulu, *Malay, Timor* *Salayer, Camarian* olo, *Tagala* hooloo, *Tonga*	kis, *Turk* kiasm, keesa, *Yakut* del, *Tunguse* tologai, *Mongol*	monoll, *Yukagir* hollud, *Samoied* kolka, *Yenisei*	musme, " gogo, " ohtshitshoo, *Kamtschatka* killa, *Kurils*
	wilan, *Shawno*	ilon, *Malagasy* ulin, *Teor* yulin, *Ahtiago* olun, *Massaratty* olum, *Cajeli* uruka, *Liang, Morella*			
	weelekeh, *Shawno*	loho, *Malagasy* aluda, *Matabello*			
	wilustikan, *Minsi* stikwan, *Cree* ochitigolue, *Algonquin* otokan, *Blackfoot* wyer, *Sankikani*	ulukatim, *Alfuros* kadou, *New Zealand* katou, *Tavoo* kahutu, *Mysol* uru, *Lariki, Saparua* urie, *Bolanghitam* kokoru, *Timor*			tchoosa, *Kamtschatka*
	puhkuk, *Massachusetts* pahlih, *Arrapaho* bequoquin, *New England* uppaquontup, *Narragansett* uppe, *Algonquin*	oupoko, *New Zealand* obaku, *Bouton* poi, *Gani*	bash, *Turk* bas, *Yakut* fej, *Magyar* poenk, *Vogul* poe, poja, *Finn* oajve, *Lapp*	eba, *Samoied* iok, *Yukagir*	bosi, *Loo Choo* kubi, *Japanese*
	weessee, *Shawno* dup, utup, *Mohican* neetop, *Penobscot*	tumbo, *Sanguir* timbonang, *Menado*	udjoo, *Mantchu*	tahig, *Yenisei*	atama, *Japanese* kashko, *Tchuktchi*
	indepecone, *Miami* neppuhkuk, *Natick* menongi, *Souriquois* monouchi, *Micmac*	nap, *Sula* nangasahi, *Galela*		ngaewa, *Samoied*	naskok, *Tchuktchi*
mouth	madoon, *Penobscot* muttoon, *Massachusetts* mettoon, *Nanticoke* maytone, *Menomeni* mitoon, *Cree* namadthun, *Bethuck*	moudoo, *Tonga* motoo, *Mariannes* moda, *Tidore* motpo, *Mysol* sumut, *Gani* numatea, *Amblaw*	awus, *Turk* ayach, *Yakut* hamun, *Tunguse* amga, " am, amma, *Mongol* aman, "	angda, *Samoied* ak, aiwa, " ngang, " nla, namo, " anga, *Yukagir* khan, *Yenisei*	kandak, *Tchuktchi* ekigin, " jeep, *Corea* cooche, *Loo Choo* kuzha, *Kamtschatka*
	indown, *Potawatomi* endonnce, *Miami* nettee, *Arrapaho* ootoun, *Abenaki*	simud, *Malay* gnootoo, *Tonga* nhoutou, *Ticopia* vudin, *Ahtiago*	umma, *Volga* wom, *Lapp* sma, *Tcheremiss* czad, szaj, *Magyar* ayak, "	kohuj, "	

	ALGONQUIN.	MALAY-POLYNESIAN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
mouth	otoun, *Mohican*		njalbme, *Esthonian*		
	wuttoon, *Narraganset*		oaiwe, *Lapp*		
	marthe, *Shyenne*	mulut, *Malay*			
	netlee, *Arrapaho*	mouloo, "			
	mossey, *Ofibbeway*	puku, *Saparua*			
	mabol, *Blackfoot*	mangai, *New Zealand*			
		mohong, *Menado*			
		mohon, *Sanguir*			
		muen, *Wayapo*			
		naonen, *Massaratty*			
tongue	weelauloo, *Penobscot*	fleeloo, *Tonga*	kyle, *Kalmuk*	alup, *Yenisei*	
	nyllal, *Etchemin*	lulo, *Malaguy*	kelen, *Mongol*	alyap, "	
	wilano, *Delaware*	lilah, *Celebes, Sanguir*	kelli, *Finn*	siolo, *Samoied*	
	ouelane, *Miami*	lobo, *Sandwich*	keli, *Esthonian*		
	weelinwee, *Shawno*	wewelli, *Allor*	kil, *Permian*		
		ellah, *Sasak*			
		ewel, *Solor*			
		melin, *Ahtiago*			
		hilat, *Java*			
		elunto, *Celebes*			
		nangalell, *Galela*			
	otalenee, *Cree*	dilah, *Celebes*	dil, *Turk*		nutphel, *Kamtschatka*
		dillah, *Tagala*			
		dila, *Bolanghitam*	till, *Yakut*		
		delah, *Baju*			
	sirpon, *Souriquois*	aran, *Mysol*		suro, *Samoied*	
		aruro, *Tahiti*		onnor, *Yukagir*	
		munarien, *Amblaw*			
	otaineni, *Ofibbeway*	tunoma, *Matabello*			
	tenanlan, *Ottawa*				
	ninanub, *Mohican*	alnum, *Alfuros*	ingni, *Tungus*	njami, *Samoied*	chay, *Corea*
	noenaunoh, *Natick*	meen, *Camarian*	enga, "	se, sie, "	stcha, *Loo Choo*
	neannan, *Nanticoke*	maanen, maan, *Bouru*	njuove, *Lapp*	andzhub, *Yukagir*	sita, *Japanese*
	minan, *Massachusetts*	maan, *Timor*; maan, *Rotti*	njuokcam, *Lapp*		
	nennanewah, *Sac & Fox*	nunawa, *Batumerah*	nych, *Magyar*		
	mitalune, *Cree*	mecolo, *Teluti*	nyelv, "		
	ooton, *Ofibbeway*	yelili, *Gilolo*	nadam, *Ostiak*		
tooth, teeth	nibit, *Algonquin*	nill, *Malaguy*			kuppet, *Kamtschatka*
	neebeet, *Abenaki, Micmac*	nifo, *Tonga, Ticopia*			
	nebidie, *Souriquois*	niphin, *Mariannes*	diah, *Turk*		ha, *Loo Choo*
	neepeetah, *Miami*	nihin, *Teor*	tees, *Yakut*		ise, *Japanese*
		nifan, *Ahtiago*	itah, *Tungus*		ji, *Corea*
	mepit, *Cree*	mopon, *Celebes*			gutuk, *Tchuktchi*
		nifoa, *Matabello*			watinka, "

	wipi, *Cree* wipit, *Delaware* webit, *Potawatomi* wypyt, *Sankikani* weebeetah, *Penobscot* veisike, *Shyenne* nepitallah, *Shawno*	iffi, *Malagasy* afod, *Gani* ipa, *Solor* ipan, *Celebes* vessi, *Ombay* waang, *Celebes* ungelell, *Pelew* kal-ifin, *Mysol*	badne, *Lapp* penk, *Ostiak*		meemaak, *Isu*
nose	tibbit, *Ojibbeway* tibit, *Algonquin* yoch, *Ojibbeway* cochay, *Montang* oocheeush, *Menomeni* yash, *Arrapaho* okissis, *Blackfoot* chassie, *Shawno* gheen, *Bethuck* kiouane, *Miami* akywan, *Sankikani* okewon, *Mohican* uchichun, *Micmac* chichkon, *Souriquois* wuchaun, *Narragansett* wikiwon, *Delaware* oakiwin, *Cree* ochengewane, *Algonquin* keeton, *Penobscot*	luka, *Morella* hihiou, *New Zealand* ihoo, *Tonga* issou, *Ticopia* ingok, *Bugis* ijunga, *Bolanghitam* oanu, *Bouton* nguno, *Galela* ngunu, *Sahoe* sonina, *Gah* swanga, *Tavoo*	tibu, *Ostiak* tewa, " ogot, *Tungus*	tody, *Yukagir* tiu, tiw, *Samoied* tibbe, tim, " ang, hang, *Yenisei*	ko, *Corea* honna, *Loo Choo* ehynga, *Tchuktchi* kaankang, *Kamtschatka*
	matchame, *New England* mikoot, *Cree* peechten, *New England* chalik, *Shawno* ochalie, " ocrisis, *Blackfoot*	hewonga, *Savu* hidong, *Celebes* bidoun, *Batchian* idong, *Malay, Sasak* *Rotti, Celebes* hengento, *Celebes* panan, *Timor* giliukani, *Teor* shonggulu, *Mysol* olleolo, *Teluti* ngilung, *Celebes* hiraka, *Liang* ngerun, *Celebes* uroh, *Baju*	chabar, *Mongol* aforo, *Mantchu* orr, *Magyar* mooron, *Yakut* burun, *Turk* silme, *Finn* sialme, *Lapp* calbme, "	patsch, *Samoied* jogul, *Yukagir* iongul, " olen, *Yenisei* olgen, "	fanna, *Japanese*
eye	mishkichi, *Cree* mishiahi, *Arrapaho* nesique, *Miami* neskesich, *Potawatomi* maishkaishaik, *Menomeni*	tumsson, *Malagasy* missak, *Pelew (see)* mntada, *Matabello* matah, *Tagala* madda, *Tuvoo*			ni, mi, *Loo Choo* liloegin, *Tchuktchi* lelengi, *Koriak*

	ALGONQUIN.	MALAY-POLYNESIAN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
eye	mata, *Cree* (see, behold)	mata, *Malay*, &c., &c.	nitoun, *Mongol*	umat, *Yukagir* (see)	dun, *Corea*
	maton, " (weep)	mato, *Java*	nidoun, *Kalmuk*		nanit, *Kamtschatka*
	schinquay, *Sankikani*	kanohi, *New Zealand*	azem, *Magyar*	sima, seme, *Samoied*	
	oskingick, *Ojibbeway*	tengo, *Malay* (see)	sem, *Ostiak*		
	kechekone, *Miami*	tangi, *Tonga* (weep)	ujihu, *Mongol* (see)		kwatshquikotsh, *Kamt.* (see)
	napiquigour, *Souriquois*		gueurmek, *Turk* (see)		netra, *Japanese*
	owopepee, *Blackfoot*		bakmak, " "		
	koeng, *Mohican*		gueuz, "	sai, saeu, *Samoied*	
	seeskeo, *Penobscot*		kasak, *Yakut*	hai, "	
	wuskeeuck, *Natick*		kus, *Uigur*	angszha, *Yukagir*	
	wuchkink, *Delaware*		kys, *Tartar*	dees, *Yenisei*	
	wuskiuk, *Mississagua*		jasza, *Mantshu*		
ear	otawagune, *Algonquin*	tayinga, *Tagala*	schan, "	ko, ku, *Samoied*	qui, *Corea*
	hadowugan, *Micmac*	tadigny, *Malagasy*	songsa, *Mongol* (hear)		eew, eewt, *Kamtschatka*
	touwango, *Penobscot*	taringa, *New Zealand*	kugach, *Yakut*		
	towakah, *Shawno*	talinga, *Malay*, &c., &c.			
	towohque, *Mohican*	dingher, *Mal.* (hear)			
	tawake, *Miami*	tenaan, *Mysol*			
	ottowug, *Ojibbeway*	tinacono, *Teluti*			
	wittawak, *Delaware*				
	wuttoowog, *Narragansett*				
	wehtough, *Massachusetts*				
	mitowukai, *Cree*				
	nootawee, *Abenaki*	motna, *Mysol*		oonomma, *Yukagir*	mime, *Japanese*
	mootchiman, *Bethuck*			kalogau, *Yenisei*	mime, *Loo Choo*
	kyttrwack, *Sankikani*	taria, *Tahiti*	korwa, *Finn*	kologan, "	mime, *Insu*
		turi, *Menado*	korot, *Tunguse*	klokan, "	
	chalksee, *Passamaquoddy*	codeelou, *Tavoo*	kulak, *Turk*	pil, *Samoied*	
		telekein-luni, *Alfuros*	fül, *Magyar*		
		toli, *Salayer*, *Sanguir*	pil, *Ostiak*		
		tilgar, *Matabello*			
hand	oleechee, *Penobscot*	ala, *Awaiya*	el, *Turk*	ol, *Samoied*	tatlichka, *Tchuktchi*
	olatshi, *Shawno*	wulaba, *Tavoo*	gol, kol, *Tartar*		meejeeree, *Loo Choo*
	lichic, "	limaka, *Morella*	kol, *Uigur*		feejeeree, "
		yari, *Mal.*, *Java* (finger)	illi, *Yakut*		ki, "
		erike, *Bajau* (finger)	gala, *Mantchu*		ti, *Japanese*
		ringa, *New Zealand*	gal, *Tunguse*		soan, *Corea*
	niligee, *Shawno*	ngalan, *Tagala*	gar, *Mongol*, *Kalmuk*		
		tanaruga, *Mangarei*	lagel, *Finn*		
	enahkee, *Miami*	lima, *Sandwich*	lagol, *Ostiak*	nugan, *Yukagir*	
	nachk, *Delaware*	lingoa, *New Zealand*	kez, *Magyar*		
	nachk, *Sankikani*	lingoa, *Tonga*			
	oniskan, *Mohican*	ouine, *Ombay*			
	michiche, *Cree*	angare, *Malagasy*			myngitt, *Tchuktchi*

[illegible]	wunnicheeke, *Narragansett* neningeen, *Ojibbeway* nenineh, *Potawatomi* peton, *Micmac* mpateen, *Abenaki* maharts, *Shyenne* maemed, *Bethuck*	dinga, *New Zealand* tangan, *Mal., Java, Bajs* numouina, *Ouh* nimun, *Ahtiago* falun, *Wayapo* falun, *Massaratty* afourena, *Tonga* nimare, *Wahai* mutnuor, *Mysol* komud, *Gani* dumada, *Matabello* limado, *Sanguir* (finger)		tokan, *Yenisei* (finger) tok, " "	settoo, *Kamtschatka*
foot	kussie, *Shawno* oaksakah, *Blackfoot* kuut, *Micmac* katah, *Miami* syt, *Sankikani* ozit, *Delaware* seet, *Natick* seetuck, *Penobscot* ahoatchis, *Blackfoot* waseed, *Delaware* wussete, *Narragansett* misit, *Cree* nauthauitah, *Arrapaho* neehahtei, *Miami* nesit, *Potawatomi* nesittun, *Ojibbeway* lelekisitan, *Cree* (toes)	kakee, *Malay* aika, *Liang, Morella* yohu, *Tidore* hoots, *Malagasy* kadan, *Wayapo* eseto, *Malay* (leg) wed, *Gani* oweda, *Matabello* tomboot, *Malagasy* afoulvae, *Tonga* matwey, *Mysol* mkalata, *Ombay* nandohu, *Galela* ungoor, *Malagasy* lefatunga, "	ajak, *Uigur* attauch, *Yakut*	nghe, *Samoied*	assi, *Japanese* asst, *Loo Choo* ljuk, *Tchuktchi* tchou-atchou, *Kamtschatka* atachi, *Japanese* tabquatshoo, *Kamtschatka* gitket, *Tchuktchi* shanna, *Loo Choo*
black	kuskeia, *Cree* suckesu, *Narragansett* shikayo, *Long Island* sicksoh, *Potawatomi* suckgek, *Delaware* skaynatsee, *Blackfoot* kuketa, *Cree* nsikkayooh, *Mohican* mooi, *Massachusetts* mowesu, *Narragansett* mokkum, *Algonquin*	ititnen, *Massaratty* bitim, *Cajeli* kokotu, *Tidore* kokotu, *Ternate* koketu, *Sahoe* kitkudu, *Gani* kudu, *Kaioa* kass, *Pelew* kameichei, *Amblaw* ngeo, *Rotti* ngoa, *Batchian* paisiu, *Dorey* mottomo, *Bolanghitam* maitun, *Sanguir*	boodal, *Tungus* kul, *Mongol* lab, *Magyar* siah, *Turk* kara, " chara, *Yakut* kara, *Tungus* fahala, *Mantchu* behe, *Mongol* hara, kura, *Mongol* fekete, *Magyar* cap, *Lapp*	noel, *Yukagir* saga, seak, *Samoied* hay, " sagar, " newai, *Samoied* smaukua, *Samoied* aimaivi, *Yukagir*	dochme, *Kamtschatka* tanjachtn, *Tchuktchi* kouni, *Aino* kuroi, *Japanese* koroea, *Loo Choo* mowukain, *Koriak*

	ALGONQUIN.	MALAY-POLYNESIAN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
black	mukuta, *Cree* mukkudaiwah, *Ojibbeway* ma-katay, *Ottawa* mahkateonquinque, *Miami* mukkoote, *Shawno* mandzey, *Bethuck*	moito, *Celebes* muhonde, *Celebes* mahitum, maitang, *Celebes* memetan, *Ahtiago* malotong, *Bugis* (Celebes) meteh, *Saparua* meddi, *Savu* mete, *Liang*, *Morella*, &c. maita, *Salibabo*	musta, *Finn*	emmitah, *Yukagir*	
white	opee, *Shawno* opeh, *Minsi* wabi, *Algonquin* wobee, *Bethuck* wape, *Delaware* wapisew, *Cree* wawbizze, *Ojibbeway* wabeek, *Micmac* wapiyo, *Passamaquoddy* wanpaeek, *Mohican* wauppauyu, *Nanticoke* wapeskaya, *Sac & Fox* wapekinggek, *Miami* wompi, *Massachusetts* wanpi, *Natick* wanbegan, *Abenaki* wompesu, *Narraganset*	boo, bus, *Mysol* kebo, *Macassar* babut, *Ahtiago* bobudo, *Ternate* pluper, *Dorey* boti, *Bouru*, *Sula* potih, *Baju* putih, *Malay*, *Ceram*, *Amboyna* pudi, *Savu* budo, *Sahoe* maputi, *Bouton* mabida, *Menado* umpoti, *Cajeli* mopotiho, *Bolanghitam* maphuti, *Matabello* maphutu, *Gah*	ak, *Turk* irungk, *Yakut* shaygan, *Mantchu* shangien, " geltadi, *Tunguse* chagan, *Mongol* zagan, " walkia, *Finn* welkes, *Lapp* vielgad, " feyer, *Magyar*	jallena, *Samoied* poinnei, *Yukagir*	siro, *Japanese* sheeroosa, *Loo Choo* attagho, *Kamtschatka* katulje, *Tchuktchi* kachtschuktuk, *Tchuktchi*
red (blood)	squayo, *Long Island* ahsain, *Blackfoot* mik, miskoosew, *Cree* mahe, *Shyenne* (blood) mesquah, *Ojibbeway* misqueh, *Massachusetts* mescone, *Algonquin* mokum, *Delaware* (blood) mohisenum, *Blackfoot* mainkhe, *Menomeni* (blood) nihpeekanneh, *Miami* " bahe, *Arrapaho* " bagakkan, *Abenaki* " poeaghkan, *Mohican* " pocagun, *Passamaquoddy* " puckeuckque, *Nanticoke* "	kao, *Liang*, *Morella*, *Saparua*, *Camarian*, *Teluti* shei, *Mysol* bashuatea, *Amblaw* (blood) mia, *Sula* miha, *Massaratty* miha, *Wayapo* mecoit, *Gani* mehani, *Amblaw* mahamu, *Menado* mosina, *Wahai* mame, *Mysol* mopoha, *Bolanghitam* poha, *Sula* (blood) abang, *Java*	kisil, *Tartar* kasil, *Yakut* kirmizi, *Turk* fulg, *Mantchu* koolani, *Tunguse* ruopses, *Lapp* veres, *Magyar* wyry, *Ostiak* puna, *Finn*	kelenni, *Yukagir*	akassa, *Loo Choo* tahaang, *Kamtschatka*

bad	mattik, *Nanticoke*	madnki, *Bouton*	muchal, *Buriat*	buschtenga, *Samoied*	neesha, *Loo Choo*
	myaton, *Cree*	mointu, *Bolanghitam*	moo, ada, *Kalmuk*	bilu, "	wasa, "
	muchisew, *Cree*	magisaki, *Bissayan*	uscho, *Mongol*	erritah, *Yukagir*	kiwo, *Japanese*
	monadud, *Ojibbeway*	mungeet, *Pelew*	eche, eget, *Mantchu*		warri, "
	makhtilon, *Delaware*	masamu, *Tagala*	kaniult, *Lamute*		warikakure, *Japanese*
	motchie, *Shawno*	nakie, *Cajeli*	eiang, "		faradate, "
	matchit, *Mohegan*	ishot, *Malay*	fena, *Turk*		khatkin, *Koriak*
	mudjt, *Ojibbeway*	jahat, "	jaman, "		guetkin, *Tchuktchi*
	matchi, *Miami*	ahati, *Wahai*	scher, "		guerkin, "
	matche, *Ottowa*	avet, *Ahtiago*	geman, *Tartar*		adkang, *Kamtschatka*
	malatisew, *Cree*	mungalotuck, *Gah*	pis, *Kirghis*	kurjast, *Esthonian*	
	maratisew, "	maraut, *Bissayan*	kuttir, *Yakut*	losogod, *Ostiak*	
	matonalkr, *Micmac*	mogult, *Pelew*	wika, *Finn*	rosz, *Magyar*	
		mugkasalla, *Bissayan*	wikke, *Lapp*	gonosz, "	
	pahkaps, *Blackfoot*	behoi, *Amblaw*	baj, *Magyar*	kul, *Vogul*	
		boossooe, *Malay*	paha, *Finn*, *Lapp*	booktshalran, *Tungus*	
good	wulillisiwi, *Delaware*	weel, *Pelew*	iol, *Magyar*	nanitallitah, *Yukagir*	
	meloo, *Cree*	aolo, *Awaiya*	ariooldooln, *Tungus*		
	galosit, *Micmac*	alla, *Baju*			
		laha, *Tidore*			
		lille, *Tonga*			
		lelei, *Samoa*			
		maholi, *Sanguir*			
		malopi, *Saparua*			
		taloha, *Galela*			
	ouret, *Sankikani*	parei, *Amblaw*		tauritah, *Yukagir*	kurassa, *Loo Choo*
	meroo, *Cree*	marope, *Bouton*			
	meyoo, *Cree*	mai, *Lariki*, *Camarian*			
	mino, *Algonquin*	maikai, *Sandwich*			
		maplya, *Salibabo*			
	mithoo, *Cree*	maitai, *Tagala*, *Austral.*	ttugai, *Yakut*		matschinka, *Tchuktchi*
		metaki, *Mariannes*			hota, *Corea*
		mutaki, *Raratonga*			
		ko-muin, *Ahtiago*			
	onishishin, *Nipissing*	ungano, *Cajeli*	sain, *Mongol*		
	oonesheeshing, *Ojibbeway*	sahenie, *Menado*	ssain, *Mantchu*		
	hacksaw, *Blackfoot*	ehia, *Tonga*	ayi, *Turk*		jukka, *Japanese*
	aghsee, "	dugosa, *Wayapo*	jo, *Magyar*		
		dugosa, *Massaratty*			
	owaisaw, *Shawno*	amaisi, *Batumerah*			
		bahai, baik, *Malay*			
		butje, *Java*			
		baji, *Salayer*			
great, large	kiche, *Cree*	aiyuk, *Ahtiago*	jaikai, *Kalmuk*	agga, *Samoied*	ikai, *Japanese*

	Algonquin.	Malay-Polynesian.	Ural-Altaic.	Asiatic-Hyperborean.	Peninsular.
great, large	gitche, *Ojibbeway*	gede, *Java*	ekzsham, *Tunguse*		okii, *Japanese*
		hast, *Massaratty*	kookas, *Finn*		kaaguk, *Tchuktchi*
	missi, *Shawno*	naiki, naaik, *Timor*	magas, *Magyar*		
	messha, *Algonquin*	monghi, *Bouton*	nagy, "	tahomoi, *Yukagir*	
	ohmohco, *Blackfoot*	wanko, *Celebes*			
	makauk, *Mohican*	owhosi, "	amba, *Mantchu*	paca, *Yenisei*	weesa, *Loo Choo*
		bobuk, *Gah*	boyuk, *Turk*	birkha, "	
		bakeh, *Salayer*		piroe, "	
		monesi, *Saru*			
		maina, *Wahai*			
	ispisew, *Cree* (high)	bagewa, *Salibabo*			
	misikiti, *Cree*	bagut, *Wayapo*			
		maata, *Raratonga*			
		matua, *Rotti*			
		enda, *Batumerah*			
	innuya, *Blackfoot* (long)	jinny, *Arru*			
		nui, *Tahiti, Sandwich*			
		Mariannes, New Zealand			
	machkilk, *Micmac*	musolah, *Celebes*	asimilshan, *Turk*		
		morokaro, *Belangkitam*	oolachan, *Yakut*		
		oleeakeek, *Pelew* (high)			
small	chuckie, *Shawno*	chi, iti, oohigi, *Tonga*	kuchuk, *Turk*		ko, *Japanese*
	sahkee, *Blackfoot* (short)	koi, *Cajeli, Liang, Lariki*			kusa, *Loo Choo*
		kickaray, *Pelew*			
	aguchin, *Algonquin*	kokuneli, *Camarian*	kichkinga, *Kasan*	kisigena, *Yenisei*	ucinan, *Kamtschatka*
		kichil, *Malay*	ukka, *Lapp*	khennonam, *Yenisei*	komaka, *Japanese*
	chimasin, *Cree* (short)	keni, *Tidore*	isi, *Tcheremiss*	kanok, *Samoied*	ucinolo, *Kamtschatka*
		gunam, *Mysol*			
	takoosew, *Cree* (short)	decheki, *Galela*			
		didiki, *Baju*	unna, *Lapp*		
	enahcootsie, *Blackfoot*	ngiti, *Raratonga*	kutshugai, *Yakut*	ngoliu, *Samoied*	
	langtitti, *Delaware*	unto, *Sandwich*	nukishookan, *Tunguse*	lukun, *Yukagir*	liuchiu, *Koriak*
		ahuntai, *Morella*	madshige, *Mantchu*	tanu, *Samoied*	ekitachtu, *Tchuktchi*
		ititi, *Samoa*	tytto, *Finn*		
		kadodo, *Salibabo*	kistin, *Magyar*		
		kidikidi, *Bouton*	kicsiny, "		
		kitti, *Wahai*	icet, *Permian*		
	upisees, *Cree*	fok, *Teor*	baga, bacha, *Mongol*		
	abisashew, *Ojibbeway*	wotawota, *Gah*	waha, *Finn*		
		walwalo, *Gani*			
		bakoti, *Amblaw*			
	pistakwin, *Blackfoot*	pindeck, *Malay*			
	panga, *Ojibbeway*	bougnia, "			
some	pache, *Cree*	paituoo, *Baju*	gael, *Turk*	(*defective*)	kuru, *Japanese*

	pahezhe, *Ojibbeway*	bomun, *Mysol*	iraku, *Kalmuk*		arkee, *Insu*
	pittasimous, *Algonquin*	buoma, *Amblaw*	lähestyn, *Finn*		
	pokhsapiti, *Blackfoot*		toole, *Tcheremiss*		
	panatao, *Cree*		tule, *Ostiak*		
	ästamoteh, *Cree*	tommymai, *Sandwich*			
		dumahi, *Sanguir*			
		maika, *Salayer*			
	ondjipi, *Nipissing*	mapa, *Tagala*			
		simepu, *Menado*			
		maive, *Bouton*			
	tootoo, *Blackfoot*	datan, *Malay*	tschi, *Mantchu*		koquasitch, *Kamtschatka*
	tukoosin, *Cree*	tao, *Tahiti*	dsime, "		
	wigun, *Micmac*	ikomai, *Wayapo*	tussim, *Mongol*		chung, *Loo Choo*
		jogmah, *Mysol*			
		gumahi, *Massaratty*			
	ome, *Shawno*	omai, *Cajeli*, *Batumerah*	joni, *Magyar*		
		hammamai, *Marquesas*	uini, *Votiak*		
		hoomy, *Sandwich*			
		uimai, *Liang*			
		mai, *Sula*, *Gani*, *Teluti*, *Gah*, *Wahai*, &c., &c.			
go	ache, *Cree*	ako, *Ahtiago*	jangam, *Ostiak*	(defective)	yuki, *Japanese*
	aji, *Algonquin*	iko, *Wayapo*			kung-chung, *Loo Choo*
		wiki, *Massaratty*			
		jog, *Mysol*			
		ai, *Saparua*			
	mahjod, *Ojibbeway*	hoo, *Sandwich*			
	machew, *Cree*	mako, *Menado*	megy, *Magyar*	ingbergbodak, *Yukagir*	
	madji, *Nipissing*	notagi, *Galela*	menni, "		
	waipthai, *Shawno*	buoh, *Amblaw*	yabu, *Mongol*		
		wo, *Tonga*	bar, *Yakut*		
		bo, *Mysol*			
		oweho, *Cajeli*			
		mapureteh, *Salibabo*	choorli, *Tungus*		
	elmyet, *Micmac*?	lampa, *Salayer*			
		lipano, *Bouton*			
		lungo, *Java*			
	kitootae, *Cree*	kotango, *Gah*	guitmek, *Turk*		howisitch, *Kamtschatka*
		taba, *Gani*			
		tetak, *Alfuros*			
		itai, *Teluti*			
eat	mechew, mechisoo, *Cree*	makeu, *Malay*	enni, *Magyar*		
	wisin, *Algonquin*				
(vocabularies	meenisi, *Arrapaho*	munga, *Pelew*			
defective)	mitishin, *Menomeni*	amu, *Tahiti*			

	Algonquin.	Malay-Polynesian.	Ural-Altaic.	Asiatic-Hyperborean.	Peninsular.
eat	magubet, *Micmac*				
	kitow, *Cree*	kahee, *Tonga*	assa, *Yakut*	rayali, *Yeniset*	owa, *Japanese*
(*vocabularies*	oyeet, *Blackfoot*	kai, *Malay*	yemek, *Turk*	lagul, *Yukagir*	
defective)	wawithene, *Shawno*	faky, *Tonga*	buis, *Yakut*	lak, "	
	oowaye, *Blackfoot*		ide, *Mongol*	langial, "	
	megelhet, *Micmac*		dscheme, *Mantchu*		
drink	mayuaan, *Menomeni*	meenum, *Malay*	ichmek, *Turk*	ondzahok, *Yukagir*	nomu, *Japanese*
(*vocabularies*	meningue, *Miami*	minum, *Malagasy*	issiem, *Yakut*	bedeam, *Samoied*	nomimono, *Japanese*
defective)	minikway, *Ojibbeway*	melim, *Pelew*	koldakoo, *Tunguse*	birebo, "	numu, *Loo Choo*
	minekwao, *Cree*	unu, *New Zealand*	jugham, *Lapp*	bitlom, "	horopsee, *Insu*
	minikwe, *Nipissing*	inu, *Tahiti*	iovva, *Finn*		
	mawminwaw, *Shawno*	inoo, *Tonga*	ilem, *Ostiak*		
	minne, *Shyenne*		ilal, *Magyar*		
	banna, *Arrapaho*				
	semate, *Blackfoot*				
	missebogunt, *Micmac*				
give	makew, *Cree*	makee, *Tonga'*	mijän, *Lapp*	keick, *Yukagir*	jaru, okuru, *Japanese*
(*vocabularies*	meenuh, *Mohican*	mahoume, *Malagasy*	annam, *Finn*		fureru, "
defective)	noumia, *New England*	nahoume, "	meian, *Esthonian*		hodekoshi, "
	minat, *Nipissing*	minta, *Moluccas*	adni, *Magyar*		quiung, *Loo Choo*
	mith, *Cree*	njockan, *Java*	sni, *Vogul*		ozagadi, "
	mih, *Algonquin*	nate, *Tahiti*	wei, *Permian*	vermehe, *Kirghis*	khineelgui, *Koriak*
	eginimow, *Micmac*	homai, "	tallel, *Ostiak*	pu, bumbi, *Mantchu*	
	cummeinsh, *Narragansett*	homy, *Sandwich*	vermek, *Turk*	og, *Mongol*	
	melaw, *Shawno*	ambil, *Moluccas*	omul, *Tunguse*	öcku, *Kalmuk*	
	ootookoot, *Blackfoot*	atoo, *Tonga*	omuli, *Lamute*	aza, *Buriat*	tunni, tunim, *Tchuktchi*
		hoata, *Sandwich*	bier, aghel, *Yakut*		chylgin, "
		angi, *Tonga*	vermehe, *Tartar*		ketam, "
speak	kitoo, *Cree*	kata, *Malay*	demek, *Turk*	aniak, *Yukagir*	ju, *Japanese*
(*vocabularies*	ikito, *Nipissing*		ittare, *Yakut*		monoju, *Japanese*
defective)	ewaw, *Shawno*	ubu, *Samoa* (speech)	kiesun, *Tunguse*		musmasu, "
	apooyaty, *Blackfoot*	boa, *Tonga*	kapsir, *Yakut*		moosaru, "
	pekiskwao, *Cree*	pesan, *Mariannes* (speech)	kisureme, *Mantchu*		munuyung, *Loo Choo*
	telawin, *Micmac*	tala, *Tonga, Samoa*	seuilemek, *Turk*		kahalkan, *Kamtschatka*
	alumew, *Cree*	bolan, *Malay*	helhu, *Mongol*		
	ierootheack, *Bethuck*	kolelo, *Sandwich* (speech)	szolni, *Magyar*		
		korero, *New Zealand* "	beszelni, "		
		lolocay, *Pelew*	kemen, *Kalmuk*		
		lea, *Tonga* (speech)	mondani, *Magyar*		
		parnu, *Tahiti*			
	itwas, wetum, *Cree*	tuatua, *Barratonga* (speech)			
	athimetak, "				
	aninutag, *Algonquin*				

kill	nitage, *Algonquin*	matheo, *Pelew*	euldirmek, *Turk*	amda, *Yukagir* (death)	korosau, *Japanese*
(vocabularies	naulat, *Arrapaho*	matte, *Tahiti*	alana, *Mongol*		shinung, *Loo Choo*
defective)	nussa, *Nipissing*	maki, *Kissa* (die)	kokan, *Tungus* (die)		kurashung, "
	enikko, *Blackfoot*	maki, *Sandwich* (die)	ölni, megölni, *Magyar*		tokok, *Tchuktchi* (die)
	nebutoo, *Micmac*	avita, *Fiji*	öldököini, "		
		fasi, *Samoa*			
	nipahao, *Cree*	pepehi, *Sandwich*	ledofni, *Magyar*		
	oshnainhnay, *Menomeni*	kukuni, *Mariannes*	kuolettaa, *Finn*		
	tahnetow, *Blackfoot*	tamate, *Tonga*	kulto, *Votiak*		
	thaw, *Shawno*	tousaoo, *Malay*			
		tai, *Tonga*			
		ta, *New Zealand*,			
		Raratonga, Austral.			
day	kijik, *Ottawa*	cocook, *Pelew*	ketche, *Tcheremiss* (sun)	kaye, *Samoied* (sun)	gaunak, *Tchuktchi*
(light, sun)	kijiss, *Algonquin* (sun)	coyoss, " (sun)	schi, tschi, *Mordwin*	kuja, " "	nitchi, *Loo Choo*
	kagigah, *Cree*	gawak, *Cajeli*	kouyach, *Tartar* (sun)	ega, *Yenisei* "	matschak, *Tchuktchi* (sun)
	kisik, *Illinois*	dawika, *Sula*	koun, " "	innag, innagi, *Yenisei*	
	kiseoukon, *Abenaki*	kikir, *Liang*	gun, *Turk*	ingni, *Yenisei*	
	keeshqua, *Shawno*	kaseirila, *Wahai*	giin, *Kasan*	kinni, "	
	keesheketh, *Sac & Fox*	kal, *Saparua*	gundus, *Kirghis*	magi, *Samoied*	
	keesuck, *Narraganset*	esug-esug, *Borneo* (morning)	kuin, *Yakut*		
	kesuk, *Natick*	esuk, *Malay* (morning)	kien, *Uigur* (sun)		
	keuse, *Bethuck* (sun)	aeasan, *Mysol*	inengi, *Mantchu*		
	kishessun, *Kickapoo* (sun)	ingkong, *Timbora* (sun)	ining, *Tungus*		tida, *Loo Choo* (sun)
	keshowghes, *Virginia* (sun)	sunjinji, *Java* "	juggut, *Votiak*		doh, *Kurile*
	kigigatte, *Algonquin*	hangat, *Wayapo* "	xat, *Ostiak* (sun)		quaatah, *Kamtschatka* (sun)
	ogunnegat, *Ojibbeway*	taginita, *Gaiela*	schoudi, *Votiak* (sun)		schekunak, *Tchuktchi* "
	kesikastao, *Cree* (light)	cenang, *Bisayan*	siouna, *Ostiak* "		aghynak, "
	pecuneah, *Potawatomi*	pagniaree, *Malay*	paiwe, *Lapp, Finn*	pondshirka, *Yukagir*	ñ, *Japanese* (sun)
		pougi pougi, *Tonga* (morning)			
	pisim, *Cree*	alvan, *Java*	paaw, *Esthonian*	tepmnan, *Samoied*	
		popongi, *Raratonga* (morning)			
	ifpete, *Miami*	fowe, *Gani* (sun)			tokaf, *Aino*
	chequikompuh, *Natick* (sun)	batta, *Batta* "			tofskaf, " (sun)
		poipoi, *Tahiti* (morning)			
	nippauus, *Narraganset* (sun)	unuvena, *Bolanghitam*	nap, *Magyar*		gaunegpek, *Kamtschatka*
	wastawin, *Cree* (light)	dowa, *Wayapo*			
	wahsahyah, *Ojibbeway* (light)	woleh, *Gah* (sun)			
	wasayow, *Cree* (light)	wangi, *Tidore* (sun)	choun, *Mantchu* (sun)		
	wasayawin, " "	wangi, *Gaiela* "			
		wagi, wai, *Formosa*	vilag, *Magyar* (light)		
	kilswa, *Miami* (sun)	kaliha, *Sanguir* (sun)	culgas, *Lapp* "	cel, jale, *Samoied*	hallo, *Koriak*
	gilswa, *Shawno* "	kila, *Teluti*	jalakas, " "	tjel, tala, "	alvui, "
	kristoque, *Blackfoot*	bilaytusang, *Rejang*	nultian, *Tungus* (sun)	jale, " (light)	lingiut, *Tchuktchi*

	ALGONQUIN.	MALAY-POLYNESIAN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
		alowata, *Morella*	punal, *Votiak*	sel, *Samoied* (sun)	
		welusita, *Tidore*	jun, *Permian*, *Sirianian*	jelonaha, *Yukagir* "	
		lew, *Teor*	gerel, *Mongol* (light)	hajer, *Samoied* "	karui, *Japanese* (light)
	kistpol, *Sac & Fox* (sun)	pilia, *Alfuros*	narau, " (sun)		akari, " "
		apalawe, *Awaiya*	edure, "		heeroo, *Loo Choo* "
	wasalow, *Cree* (light)	watiela, *Batumerah*	eder, *Kalmuk*, *Buriat*		feeroo, " "
	wasarow, " "	mataron, *Menado* (sun)	tirgani, *Tunguse*		
	wasalawin, " "	matalima, *Ahtiago*	nur, *Turk* (light)		
	wasarawin, " "	mantarai, *Malay* (sun)	sirdik, *Yakut* (light)		
		massoanro, *Malagasy* (sun)			
		matalon, *Baju* "			
		matualo, *Salayer* "			
		matauri, *Malay* "			
	nishilah, *Arrapaho* (sun)		nunass, *Votiak*		nitji, *Japanese* (sun)
night (*darkness*, *moon*)	dabicott, *Ojibbeway*	daputo, *Galela*	jaukoba, *Vogul* (moon)	pidsiga, *Yenisei*	tyngfouti, *Koriak*
	dabikat, *Algonquin*	sophuto, *Tidore*	begh, *Tunguse* "	bicidin, "	yoru, *Japanese*
	tippocat, *Narraganset*	matalmt, *Ahtiago*	bjega, " "	bis, "	josari, "
	tpoku, *Delaware*	carpasay, *Peleo*	sara, *Mongol* "	pausemya, *Samoied*	atsiroo, *Aino*
	tepocq, *Mohican*	gubie, *Bolanghitam*	hoid, *Magyar* "	paebi, "	kolkwa, *Kamtschatka*
	tpochku, *Minsi*	hubbi, *Sanguir*	kouli, *Esthonian* "	faemi, "	
	tepechke, *Shawno*	pogaragara, *Teor*	tolya, *Permian*, *Sirianian* (moon)	pi, fi, fing, "	
	tipiscow, *Cree*	pai, *Gani* (moon)	idal, *Ostiak*	poinjaletok, *Yukagir* (evening)	
	pesede, *Abenaki*	potu, *Saparua*	kemnlik, *Turk* (dark)	yirri, iri, *Samoied* (moon)	mime, *Japanese* (dark)
	pekotek, *Menomeni*	petu, *Cajeli*	kharangha, *Yakut* (dark)	kininsha, *Yukagir* "	kurasing, *Loo Choo* (dark)
	piskak, *Delaware*	beto, *Wayapo*, *Massaratty*	ai, *Turk*, *Uigur* (moon)	emmel, "	mangeta, *Japanese* (moon)
	pishkeeaukh, *Micmac*	bohuwi, *Sula*	ooi, *Yakut* (moon)	emmitach, " (dark)	gailgen, *Koriak* "
	pekuntesue, *Miami*	bekomo, *Gani*	tun, *Uigur*		geiligen, " "
		potuun, *Alfuros*	tuin, *Yakut*		tehagaloh, " "
		bungi, *Java*	dolbeni, *Tunguse*		kounetson, *Aino* "
	nipahune, *Delaware* (moon)	fasina, *Sula* (moon)	golban, *Tunguse*		oostitehee, *Loo Choo* "
	nepauk, *Mohican* (moon)	bonan, *Tagala* (moon)	keesse, *Yakut* (evening)		maroo, *Loo Choo* "
		wuan, *Gah* (moon)	guejeb, *Turk*		yuru, " "
	nukon, *Massachusetts*	mangong, *Timbora* (moon)	koun, *Finn* (moon)		unujak, *Tchuktchi*
	skaynatsee, *Blackfoot* (dark)	sangun, *Baju*	sun, (*Mongol*)	nödi, *Samoied*	tankuk " (moon)
	cequay, *Blackfoot*	ahiabi, *Tahiti*	ku, kou, *Finn* (moon)	khi, kui, *Samoied* (moon)	tschatame, " "
	kisis, *Illinois*, &c. (moon)	oan, *Galela* (moon)	ku, kou, *Mordwin* (moon)	shui, kui, *Yenisei* "	tsuki, *Japanese* "
	kisathwn, *Shawno*, &c. (moon)		ej, *Magyar*	tui, " "	stchay, *Loo Choo* "
	lenaupee keesho, *Missisagua*		jugun, *Finn*	ud, gigod, *Samoied*	doohsae, *Kamtschatka* (dark)
			harangui, *Mongol* (dark)		
			moorak, *Tunguse* (evening)		
one	bejig, *Ojibbeway*	pasho, *Uea*	vaike, *Mordwin*	irken, *Yukagir*	syhnap, *Kamtschatka*
	peyak, *Cree*	wasa, *Batumerah*	bir, *Turk*		shnepi, *Tarakai*
	pejik, *Algonquin*	sawiji, *Java*	bir, *Yakut*		sinesf, *Yesso*
	pessick, *Penobscot*	soboto, *Bolanghitam*	sutt, *Lapp*		sheeneap, *Insu*

	bechkon, *Kichemin*	sabi, *Amblaw*	oomun, *Tungus*		
	pasuk, *Natick*	tepao, *Gani*	mukoun, *Tungus*	chusem, *Yenisei*	
	neegut, *Melicete*	parai, *Balad*		chusam, "	
	woomnut, *Piankashaw*	sembaow, *Salibabo*		chuta, "	
	cotch, *Delaware*	heta, *Yengen*	otik, *Permian*	hucha, hauta, *Yenisei*	te, teetsee, *Japanese*
	cutta, *Sankikani*	sato, *Malay*	otik, *Sirianian*	hocha, *Yenisei*	itchee, *Loo Choo*
	quuttie, *Shawno*	sadah, *Batta*	iits, *Esthonian*	khusel, "	iz, stosee, *Japanese*
	nquit, *New England*	sedi, *Bugis*	it, *Ostiak*		stitz, *Insu*
	ingota, *Miami*	satu, *Sambawa*	nige, *Mongol*	om, *Samoied*	hodjun, *Corea*
	nquit, *Narraganset*	katim, *Mysol*	nege, *Buriat*	unem "	hotun, "
	negout, *Souriquois*	kotahai, *Easter*	xege, *Dzungarian*		kemmis, *Kamtschatka*
	necootie, *Shaweno*	atahai, *Otaheite*	nege, *Khalka*		
	nout, *Micmac*	nosiuni, *Massaratty*	negen, *Olete*		
		moi, *Galela*			
	nuke, *Shyenne*	nehi, *Manatoto*			
	su, *Blackfoot*	sa, *Malay, Java, Amboyna, Baju*, &c., &c., &c.			
	jih, *Blackfoot*	it, *Malay*	ik, *Tcheremiss*		
		hia, *Sula*	egy, *Magyar*		
		hoe, *Tahiti*	yksi, *Finn*		
	chasu, *Arrapaho*	kusa, *Sanguir*			
		ohas, *Lifu*			
		kayee, *Teor*			
	tookakum, *Blackfoot*	tatasat, *Formosa*			
		tahi, *Marquesas*, &c., &c.			
		takura, *Serang*			
two	tabo, *Souriquois*	duwa, *Bugis*	gojer, *Mongol*	antachlon, *Yukagir*	tup, *Tarakai*
	tanbw, *Micmac*	dulava, *Manilla*	koir, *Buriat*	kydy, *Samoied*	suzb, *Yeso*
	tarpoo, *Melicete*	dalava, *Tagala*	chojur, *Dzungarian*	syda, "	fupu, *Corea*
	neguth, *Shyenne*	sinuto, *Galela*	chour, *Khalka*	ynem, *Yenisei*	dupk, *Kamtschatka*
	nahtoka, *Blackfoot*	remodetti, *Tamati*	chojer, *Olete*	unem, "	ne, *Japanese*
	nij, *Ojibbeway*	nua, *Sava*		ince, "	nee, gnee, *Loo Choo*
	neesoh, *Mohican*	sua, *Mangarei*		una, "	ta, tatzee, *Japanese*
	nenoo, *Cree*	sua, *Flores*		inja, "	statzee, "
	nisha, *Delaware*	agua, *Tuham*	iki, *Turk*	kina, "	too, stats, *Insu*
	neshway, *Miami*	gahu, *Sula*	ikke, *Yakut*	hineang, "	mittanoo, *Kamtschatka*
	neesh, *Penobscot*		kaksi, *Finn*		
	nels, *Arrapaho*		kats, *Esthonian*		
	nees, *Montaug*		kok, *Tcheremiss*		
	neese, *Massachusetts*		kavto, *Mordwin*		
	nise, *Abenaki*		kyk, *Permian, Sirianian*		
	nees, *Potawatomi*		kat, *Ostiak*		
	nyese, *Sankikani*		ket, *Magyar*		
	neeshwie, *Shawno*		djuhr, *Tungus*		
	nesnog, *Natick*				

	ALGONQUIN.	MALAY-POLYNESIAN.	URAL-ALTAIC.	ASIATIC-HYPERBOREAN.	PENINSULAR.
three	nis, *New England*	nih, *Timbora*	uch, *Turk*	nagor, *Samoied*	san, *Japanese*
	noghah, *Mohican*	sangi, *Galela*	ews, *Yakut*	touga, *Yenisei*	sang, *Loo Choo*
	nacha, *Delaware*	ange, *Galela*	kolme, *Finn*	tjouga, "	sai, *Corea*
	nacha, *Sankikani*	ange, *Tidore*	kolm, *Esthonian*	douga, "	mee, meetsee, *Japanese*
	nethwie, *Shawno*	neti, *Paumotuan*	kum, *Tcheremiss*	dongeen, "	tshusquat, *Kamtschatka*
	nistoo, *Cree*	kunete, *Lifu*	kolmo, *Mordwin*	dogom, *Yenisei*	mitz, *Insu*
	gicht, *Souriquois*	gatil, *Sula*	kujim, *Permian*, *Sirianian*	ialon, *Yukagir*	liep, "
	sist, *Melicete*	tigu, *Malay*, &c.	chudem, *Ostiak*		repf, *Tarakai*
	seast, *Micmac*	othey, *Pelew*	harom, *Magyar*		rezb, *Yesso*
	nash, *Abenaki*	veti, *Isle of Pines*	kolm, *Lapp*		raph, *Kamtschatka*
	nas, *Arrapaho*	kuu, *Uea*	elan, *Tunguse*		
	nish, *Narraganset*		ilanu, "		
	nahe, *Shyenne*		churban, *Mongol*		
	nass, *Penobscot*		gurban, *Buriat*		
	nach, *Etchemin*		gurba, *Dzungarian*		
	nissin, *Ojibbeway*	hayen, *Yengen*	gurba, *Khalka*		
	nesweh, *Miami*		gurban, *Olots*		
	nisswi, *Nipissing*				
	nahhoka, *Blackfoot*				
	nishuah, *Natick*				
	nishwoner, *Piankashaw*				
four	yehhoo, *Penobscot*	ahka, *Kissa*	durban, *Mongol*	shega, *Yenisei*	sy, *Japanese*
	yoh, *Narraganset*	ha, aha, *Sandwich*, *Marquesas*	derbyn, *Buriat*	shegiang, "	shee, *Loo Choo*
	yaw, *Massachusetts*	han, *Rotti*, *Easter*	dorbo, *Dzungarian*	chega, "	yoo, *Japanese*
		ahaa, *Otaheiti*	durba, *Khalka*	ziang, "	eeotsee, *Japanese*
		hah, *Sava*	dorbon, *Olots*	siam, "	yeatze, *Insu*
	yeane, *Arrapaho*	oang, *Pelew*	digon, *Tunguse*	syjem, "	eenep, "
	neawe, *Shawno*	ampah, *Lampon*	degenu, "	shaja, "	tahascha, *Kamtschatka*
	nave, *Shyenne*	ampat, *Malay*, &c.	neljä, *Finn*	deite, *Samoied*	inezb, *Yesso*
	nasowe, *Blackfoot*	kopa, *Sanguir*	nelli, *Esthonian*	tade, "	inipf, *Tarakai*
	newo, *Delaware*, *Cree*	beu, *Isle of Pines*	nil, *Tcheremiss*	jelahlon, *Yukagir*	yhnap, *Kamtschatka*
	new, *Algonquin*	pa, *Celebes*, *Bouru*	nile, *Mordwin*		nai, *Corea*
	now, *Micmac*	fa, *Tonga*, &c.	njolj, *Permian*, *Sirianian*		
	naou, *Sheshtapoosh*	enhata, *Alfuros*	njeda, *Ostiak*		
	neo, *Nipissing*	ope, *Paumotuan*	negy, *Magyar*		
	niwin, *Ojibbeway*	opak, *Bugis*	dirt, *Turk*		
	nayboo, *Melicete*	maha, *Tahiti*	tirt, *Yakut*		
five	nan, *Micmac*	nim, *Caroline*	besh, *Turk*	chajem, *Yenisei*	koomdas, *Kamtschatka*
	nanan, *Ojibbeway*	nima, *Tonga*	bes, *Yakut*	kakjam, "	ahsik, "
	nanan, *Nipissing*	nima, *Wahai*	viisi, *Finn*	gagem, "	go, goo, *Loo Choo*
	niyanan, *Cree*	nim, *Yengen*	wiis, *Esthonian*	cheilang, "	go, *Japanese*
	noane, *Shyenne*	aeem, *Pelew*	vis, *Tcheremiss*	geijang, "	ittitsee, *Japanese*
	nesstoo, *Blackfoot*	matoha, *Galela*	väte, *Mordwin*	kega, "	idotsee, "
	naisetow, "	neka, *Paumotuan*	vit, *Permian*, *Sirianian*	khala, "	itzeitsee, *Insu*

naulon, *Delaware*
nalanum, *Cree*
neallonwe, *Shawno*
neraaum, *Cree*
yorthun, *Arrapaho*
palenach, *Delaware*
pohlenish, *Penobscot*
six nahoh, *Blackfoot*
neyu, "

nitahter, *Arrapaho*
nahsato, *Shyenne*
negulaus, *Abenaki*
nacuttah, *Montang*
husagum, *Micmac*
asigum, "
negotanee, *Penobscot*
enkwitash, *Delaware*
karmarchlu, *Melicete*

nigotwasswi, *Ojibbeway*
nikotwasik, *Cree*
necootwathwee, *Shawno*
guttach, *Delaware*
seven kitsic, *Blackfoot*
akitsecum, *Blackfoot*
tepakup, *Cree*

tambaohoos, *Penobscot*

nisoto, *Shyenne*
neswawthwe, *Shawno*
nijwasswi, *Ojibbeway*

nesooasuk, *Cree*
nichach, *Delaware*
nisorter, *Arrapaho*
eloohaykenuck, *Melicete*
aluginoo, *Micmac*

kechegum, *Blackfoot*

lima, *Malay*, &c., &c.
limanu, *Bouton*
enlima, *Alfuros*
ereema, *Otaheiti*
romatoha, *Tamati*
panim, *Balad*
pulu, *Tagala*, &c. (ten)
noh, *Amblaw*
noi, *Teluti*
nooh, *Saparua*
noo, *Lariki*
nota, *Isle of Pines*

gane, *Sula*
kanum, *Sanguir*
butanga, *Galela*
nimwet, *Yengen*
gurum, *Tuham*
malong, *Pelew*

hitu, *Marquesas*
aheitoo, *Otaheiti*
kapitu, *Sanguir*
gapitu, *Sula*
kumba, *Timbora*
tumodi, *Tidore*
tumidingi, *Galela*
tomdi, *Tamati*
enhit, *Alfuros*
witu, *Awaiya*
petu, *Java*, &c.
nobo, *Isle of Pines*

luengemen, *Lifu*
loiitfou, *Isle of Moses*
loalo, *Uea*
nim weluk, *Yengen*

vet, *Ostiak*
öt, *Magyar*
wit, *Lapp*
tona, tongou, *Tunguse*
tabun, *Mongol*, *Buriat*
tabu, *Dzungarian*, *Khalka*, *Olots*
alti, *Turk*
alta, *Yakut*
kunsi, *Finn*
kuus, *Esthonian*
kut, *Tcheremiss*
koto, *Mordwin*
kvait, *Permian*, *Sirianian*
chut, *Ostiak*
hat, *Magyar*
kut, *Lapp*
kot, *Vogul*
dsirohu, *Mongol*
ddjergon, *Buriat*
surga, *Dzungarian*
asurga, *Khalka*
surgan, *Olots*
kilkok, *Tunguse*
nunun, "
yeddi, *Turk*
setu, *Yakut*
seitsemän, *Finn*
seitse, *Esthonian*
sim, *Tcheremiss*
sisem, *Mordwin*
sizim, *Permian*, *Sirianian*
tabet, *Ostiak*
het, *Magyar*
naddan, *Tunguse*
etgatanok, *Tunguse*
dolochun, *Mongol*
dolon, *Buriat*
dolo, *Dzungarian*, *Khalka*
dolon, *Olots*

sumulu, *Samoied*
shumbila, "
tetti, "
engaulon, *Yukagir*

muktum, *Samoied*
malghialon, *Yukagir*
ahjem, *Yenisei*
ages, "
agam, "
aggiang, "
gelucha, "
kelucha, "
ogga, "
gelluddgang, *Yenisei*

oujang, *Yenisei*
ohnem, "
ouse, "
erham, "
umya, "
geiliniang, "
kelina, "
kube, *Samoied*
seigbe, "
purchion, *Yukagir*

asheak, "
tashu, *Corea*
asheki, *Tarakai*
ashikinipf, *Tarakai*
assikim, *Yesso*
assaraneeof, *Yesso*

mootsee, *Japanese*
nitzee, "
rok, "
rooko, *Loo Choo*
jushu, *Corea*
nits, *Insu*
ewan, "
juwambi, *Tarakai*
juiwanbe, *Yesso*
iwam, "
kilkoas, *Kamtschatka*
chguachu, "

stchee, *Loo Choo*
siz, *Japanese*
nannatsee, *Japanese*
arrawan, *Insu*
aruwambi, *Tarakai*
aruambi, *Yesso*
aruwam, "
jiku, *Corea*
aruachu, *Kamtschatka*
ittachtenu, "

	Algonquin.	Malay-Polynesian.	Ural-Altaic.	Asiatic-Hyperborean.	Peninsular.
eight	alenanoa, *Cree*	veluano, *Bouton*	kahdexan, *Finn*	malgialachlon, *Yukagir*	tahokteun, *Kamtschatka*
	aumulchin, *Micmac*	enwol, *Alfuros*	kattesa, *Esthonian*	geiltangiang, *Yenisei*	duhpyhs, "
	hogomulchin, *Melicete*	eialou, *Isle of Moses*	kändäxe, *Tcheremiss*	chajem-dogom, "	toopish, *Insu*
		walou, *Malagasy*, &c.	kavsko, *Mordwin*	tunem-boisem-chogem, *Yenisei*	yeatz, "
	narneswenm, *Blackfoot*	karua, *Salayer*	kokjamys, *Permian*, *Sirianian*	hun-basi-ang, *Yenisei*	tubishambi, *Tarakai*
	arenanoa, *Cree*	waru, *Amboyna*, &c.	nida, *Ostiak*	kattaga, "	sujemambi, *Yesso*
	ayenanew, "	koneho, *Timbora*	njolex, *Magyar*	chetonga, "	zubsam, "
	nahnni-aweyeme, *Blackfoot*	nim-woyen, *Yengen*	kykiamis, *Permian*	kina-manchan, "	faz, *Japanese*
	nishwasswi, *Ojibbeway*	kun-engemen, *Lifu*	sekkez, *Turk*	kuydeite, *Samoied*	ceyatsee, *Japanese*
	nanemck, *Penobscot*	wan, *Caroline*	ogos, *Yakut*	syetade, "	iosee, "
	swassik, *Cree*	saya, *Kayan*	djapkull, *Tunguse*		jita, *Corea*
	ebach, *Delaware*	gatahua, *Sula*	tshokotenok, *Tunguse*		fatchee, *Loo Choo*
	nghash, "	wagu, *Teluti*	naiman, *Mongol*		kwatchee, "
	nahnoto, *Shyenne*		najaman, *Buriat*		
	nahnorter, *Arrapaho*		naima, *Dsungarian*, *Khalka*		
	thwawsickthwe, *Shawno*		naiman, *Olots*		
nine	shack, *Cree*	signa, *Tuham*	dokkuz, *Turk*	togos, *Samoied*	jahao, *Corea*
	shangasswi, *Nipissing*	sanga, *Java*	tagos, *Yakut*	chajem-sysem, *Yenisei*	eoo, *Loo Choo*
	cangaswi, *Algonquin*	skengemen, *Lifu*	tahukatomok, *Tunguse*	chusem-boisem-chagem, *Yenisei*	kon, *Japanese*
	jangwasswi, *Ojibbeway*	sin, *Mysol*	ijogjin, "	chuta-janos-cheijang, "	kokonitz, *Japanese*
		sioanu, *Bouton*	jisun, *Mongol*	god-ijibunagiang, "	kounitsee, "
	sokenardek, *Melicete*	lothack, *Uea*	jihon, *Buriat*	huchabunaga, "	lepish, *Insu*
	kekamitatat, *Cree*	mutauda, *Formosa*	jesu, *Dsungarian*, *Khalka*	khusa-manchan, "	shnebishambi, *Tarakai*
	chawkuthwe, *Shawno*	gutusia, *Sula*	jesum, *Olots*	chunierki-ellendzshien, *Yukagir*	sinesambi, *Yesso*
	shautah, *Arrapaho*	stew, *Pelew*	yhdeksan, *Finn*		sinobsan, "
	soto, *Shyenne*	siyu, *Tomati*, &c.	iitesa, *Esthonian*		synahpyhs, *Kamtschatka*
		sambden, *Sambawa*	endexe, *Tcheremiss*		tshaktanak, "
		sioh, *Timor*, *Rotti*, &c.	vaikse, *Mordwin*		
	nole, *Delaware*	sambilan, *Malay*, &c.	ökmys, *Permian*, *Sirianian*		
	nohtee, *Penobscot*	lali, *Timbora*	arjong, *Ostiak*; kilencz, *Magyar*		
ten	mahtoto, *Shyenne*	mackoth, *Pelew*	arban, *Mongol*, *Buriat*	kunielk, *Yukagir*	keumtook, *Kamtschatka*
	mahtahtah, *Arrapaho*	manud, *Tuham*	*Khalka*, *Olots*	tchium, *Samoied*	upyhs, "
	midasswi, *Ojibbeway*	putusa, *Serang*	arba, *Dsungarian*	bet, "	wambi, *Tarakai*
	neetawthwee, *Shawno*	painduk, *Yengen*	tshomkotak, *Tunguse*]	chojum, *Yenisei*	wambe, *Yesso*
	mitaswi, *Nipissing*	fotusa, *Ahtiago*	djanu, "	kogom, "	fambe, "
	mitatat, *Cree*	hutusa, *Awaiya*	own, *Turk*	chogem, "	wanna, *Insu*
	tellin, *Delaware*	teran, *Matabello*	on, *Yakut*	hagiang, "	yoo, too, *Japanese*
	tillun, *Melicete*	saromi, *Timbora*	lava, *Uigur*	chaha, "	siou, "
	matala, *Penobscot*	nulu, *Manatolo*	kymmeven, *Finn*	haga, "	joo, dzoo, *Loo Choo*
	umtolen, *Micmac*	ongofoolou, *Tonga*, &c.	kümme, *Esthonian*	khoa, - "	je, *Corea*
		nafula, *Samoa*, &c.	lu, *Tcheremiss*	chaijung, "	
	chitnorth, *Micmac*	nauru, *Raratonga*	kämen, *Mordwin*		
	kaipoo, *Blackfoot*	kapuroh, *Sanguir*	das, *Permian*, *Sirianian*		
	wimbat, *Delaware*	tebennete, *Uea*	jong, *Ostiak*		

		vuta, *Ahtiago*	tis, *Magyar*		
		boto, *Cajeli*	lokke, *Lapp*; lu, *Vogul*		
hundred	mitana-mitina, *Cree*	hutuna, *Amboyna*, &c.	dsun, *Mongol*, *Buriat*	kysaah, *Yenisei*	sing, *Loo Choo*
	mittausau-mittawnaw, *Ojibbeway*	hutun, *Ceram*, &c.	dsu, *Dsungarian*, *Khalka*	kyha, "	
		uton, *Mysol*, &c.	suhu, *Olots*	utamsa, "	
			nemadje, *Tungus*	tchius, *Samoied*	
				dsoon, "	

VOCABULARY II.

Comparison of Characteristic Forms in Algonquin, with the same in the Languages of Neighbouring Families.

	Algonquin.	Athabascan.	Iroquois.	Dacotah.	Choctaw.
man	lenno, ilinni	aille, tenalo, tchelaqui	lonque, lookque	hihna	
	renoes		ronkwee, raniha		
	ithini	dinnie, tine, tengi	etschinak	wicasta	hatak
	nah, inini	khanae, sikkanne	eniha, hajinah	wineha	nockene
	ninaben			numohk	
	wessis			wahsheegae	
	tommawahew			oeeteka	chauheh
	mahtsee	enday, nde	entequos	matse	
woman	wiwah, wewemow			wako, weah	
	newah		kanenwenh	mega, meha	
	abitase				tike, hoktie
	eskwa, ichque	iayquay, chequois	yonque		ohoyo, chauhiwauh
child	enese, negusis	yaze	ixhaa	chincha	ushe
	awansis, owasis	trinyin	raxaah	wahcheeah	
	pappoos	sle, toju	woccanoune	hoksiyopa	pooskoos
	apiloasah	quelaquis	kotonia	sookhomaha	vila
	necovis	tenaiyusa			
boy	ianis, nekeesh	tinji, tenatu	haksaah	eeneek	nokkene
	bawtoos	tsiah, tcho	raxha, laxha	hoksidang	choppootche
	quises	azay, syaseh	yung, chahinks	eeingyai	ushi
girl	danis	idazoo, ete	yaweetseutho	meyakatte	take
	mitanis	nitsit	ekrojehawak	wechincha	oshetik
	panum	lengai, keel		meha, mega	
	epidek	chi, ma	yakenwaston	weetsheeahnah	villa tak
	squasese	syaseh, sekus	exha, kaxha		
head	wil, wilan	umitly	onoalagoue		
	wyer	se wolyer	otahra, anuwara	marahaa	ecau
	stikwan	astintah, hutseetsin	akotan, sconta		isteka
	uppa, puhkuk	pitsa, betthie		pa, pahhih	eebuk

	ALGONQUIN.	ATHABASCAN.	IROQUOIS.	DACOTAH.	CHOCTAW.
head	dup, neetop	ethi, thie		antu	nishkubo
	menongi	sugha, aissagge	nontsi, ranontsi	naso	
mouth	madoon, indown	ta, edha	wachsagaint	ei, ea, ihah	iti
	nettee, meessey	chezhik, huzzay	chigue	pootay	
	marthe	kasstl	oosharunwa		
	netlee	salotte	wachsacarlunt		
tongue	weelauloo, wilano	lasom			soolish
	mitalune	thoula, tsoola			soonlush
	nirnou	sheedare		rezi	istetolahswah
	tenanian	kanat	owanauchsuh	cozi	
	minan, nearnan	soh, huzzy, chicha	ennasa	dezi	
	ootou	ethu, edthu	enachse	theysi	
tooth	nibit, mepit	goo, chagoh	onawy	i	noteh
	wipi, webit	howwah, howgo	onotchia	hi	noteeh
	veisike	sheego	honozzia	ei	
	nepitallah	sawyer, hurgo	onawira		
	tibbit	shti	otoatseh		
nose	yoch, chassie	seetzee	oojyasa		
	gheen, chichkon	chintsih	onuhsah		
	wikiwon	witchess	aongya		
	keeton	hutchin, khointsus	kakondah		
	mikoot	mintshesh		pahoo, pasu	
	peechten	neuzeh		pute	isteeopooh
	chalik	kaljuatsch		apa	ebitchella
	ocrisis	schintschish		buppa	
eye	miskichi	nackhay, nakhai			nishkin
	mate	ente		meishta	eenoakeen
	schinquay	ssnega	yochquiendoch	ista, ishta	
	kechekoue	konda, chindar	ohuchta	estume	
	nepiquigour	senourvoh	okahra	ite	
	owopspee	pindah	acoina	ister	
	seeseeko	schindah	kaka		
	wuskink	sleeda, sleenda			
ear	towakah	hutchah	ookahnay	naughta	tseehokolo
	wittawak	wickyah	ohontah	neetah	kutseo
	nootawee	azoga, tshigha	ohuchta	noge, nakoha	
	hyttrwack	ocho, zach	wauntah	nakpa	ockseebish
	chalksee	azulu			haklo
hand	oleechee, niligee	hollah, shlaa	shake		ilbock
	nahck	inla, lah	kaschuchta	onka	iunkkee
	oniskan	skona	osnonsa	naue	istinkeh
	nenineh	kajakaz	osnoongee	sake, shagai	
	peton	wislah		nape, nonpay	ibbak
	maharts	chinli, law	ahonressa		

	maemed	salur	yoreesaw		
foot	kussie	chekeh, kagasch	saghsige	siha, sih	iyi
	katah	schkatna	oohaits	itsi	yeyeh
	seet	stah	sita, ochida	the, tsi	
	waseed	eke, oca, cuh	ooseetaw	buschee	
	nesit	ahke, seka	saseeke		
	lelekistan	jetly, skaltna	sheedau		isteeleetoppixsee
black	kusketa	klazin	tetiucalas	sapa	echatau
	suckgek	huldji		sewi	loosah
	skaynatsee	tkhlaune	hontsi	tpazz	lusteeh
	mowesu	dellzin	yorwetsoyuh	eokhpazek	
	mukkoote	tarzi	tewhgarlaro		
	mandzey				
white	opee	lakki, halukai	kenrat	aka	bota
	wape	delksay	kearagea	sang	
	wabeek	takaih	wrahesta	ataki	
	wompi	itesina			
red (blood)	squayo	delicouse, tutkhl	quwentarogon	wahsah	issish
	ahsain	tatsik, takakuete	youtkojunya	hishi	homma
	mik, mesquah	tell	hotkwensa	duta	
	mainkbe	sko	cotnuh	idi	
	bahe, pockagun	tah		we	
bad	mattik	satklaka	wahetka	shicha	
	muchisew	nizikwah	hetken	khecush	
	monadud	tschoolta	yodaksea	ishia	
	malatisew	sleni	aksen	cheja	okpulo
	maratisew	koschijal	yeghserohea		
	pahkaps		wahpateku	kubbeek	
good	wulilliswi	thloucunni			achukma
	ouret	leyzong	ioyanere		chookoma
	meyoo	nirzih			heetla
	mino	meeheesoo		uohta	
	mithoo	ouchon		tsaki	
	onishishin	nazoon		shusu	
	aghsee	sutschon	wagwast	washtai	
	owaisaw	itait	wastaitch	itsicka	
great	kiche	cha, choh	kowa	hashkah	ishto
	gitche	tchos, tcha		tangka	chito
	messha	nitsih			
	ispisew	wane			
	misikiti	mintshaghe		ictia	
	innuya	nekau	hons	honska	
	machkilk	unshaw			
small	chuckie	tsoota	ostonha	cisting	
	aguchin				

	ALGONQUIN.	ATHABASCAN.	IROQUOIS.	DACOTAH.	CHOCTAW.
small	chimasin	chantah		tonana	
	takoosew	astekwoo	diwatsa	ecat	
	anahoootsie	nacoutza		cikadang	iskitini
	langtitti	tsul, nettsul			
	upises	ensoole			
	pistakwin				
	punge				
come	pache	chatchoo	kajee	kuya	via
	pitassimous		kats	hiya	
	panatao	anyat	karo	hi	
	astamoteh	yendessay		a	
	ondjipi	andessi			
	tootoo	yuksosin-essal			
	wigun				
	ome	ane, orne			
go	ache	essay	iki	ya	ia
	machew, madji	eenio	aghdeandi		
	waipthai	antonger			
	elmyet	anahsonttee			
	kitootao				
eat	mechew	setse	higuekch		
	mennisi	iahshan	irakn		
	wisin	beha		duti	vpa
	mitishin	chesti		wota	impa
	kitow	utsits, shatee	shadige	utah	
	wawithene		dahontsikahon	utahpe	humbilischa
	megelhet	kelikatj	yusyhoory	yooshteosh	
drink	maynaan	chidetleh	uttanote		ishko
	minikwe	mijohny	akhnekira	hi	hishko
	minne		guehra	yatkang	
	banna			beedeehee	
	semate	esdan		smimmik	
	misseboguet			nebnatah	
give	makew		waghsaka	accuje	ema
	meennh	besanesdi	cassar	ku, khu	
	mith	entar	kayahwe		
	eginemow	antechatte	wahetky		
	cummeinah	dhushitscha			
	melaw	hamiltu			
	ootookoot				
speak	kitoo	kanna	haguetaa	yaotangin	
	ewaw, apooyatz	tini	ehawtonk	ide	
	pekiskwao			bidow	
	telawin	katlijach		ia	

	ierootháck	yaltuck	raton		
	itwao	yawsthee, yasti	atakea		
	animutag				
kill	nitage	tridhehlkai	kerios		numpuli
	enikke	uzeagha			
	nipahao	lesanesshi		kita	abi
	tahnetow	thla, thloa		kte	uhbe
	thaw	siltir		ta	
day	kijik, kisik	kakech	gachquaw	cang	neetak, nittah
	ogunnegat	cheengo, cajane	andakagagua	ohjajo	hushi, hashee
	pecuneah, pesim	dzine, janes, tain	wahnta	haunip	
	ifpete	tschan, kan	ootaune	anpetu	
	nippauus	apach	onteka	ompah	
	wastawin	taosse, tsa	wende	thieshe	
	wasayow	sah, tchay	hiday	weehah	
	kilswa	tiljcan, klut	kilanquaw	ahhiza	
	cristoque	drin, attri	garachquaw	menahkah	
	kisipol	katakyl	yoohooks	wee	
	wasalawin	shaitlititi	yorhuhuh	mapemidi	neethleh
	wasarawin	rseye	ennisera		
night	debicott	sah, kacha	karakkwa	owee	opia
	pesede	tata, tedhe	heegtheh	aoui	
	piskak	shetsill	kelanquaw	estogr	
	nepauk	taltolla	kachqua	onhape	
	nukon	kleakut, khutli	autsunye	maku	nennak
	skaynatsee	sulchati	asonthen	hangyetu	hashenesnak
	eaquay, kisis	hkah	sonrek	oche	hushi
	lenaupee keesho	tlakannoo	aghsont	htayetu	

VOCABULARY III.

Comparison of Pronouns.

	Algonquin.	Malay-Polynesian.
I	neya, *Cree*	naak, *Pelew*
Thou	keya, "	kow, *Pelew*; kowe, *Ponape*
	ki, *Delaware*; kee, *Shawno*	koe, *New Zealand*; coy, *Tonga*
	ki, *Ojibbeway*	koai, *Malay*
He	noh, *Natick*; neha, *Delaware*	na, "
	weya, *Cree*	iya, *Tagala, Malay*
	oo, *Shawno*	aia, *Tonga*
We	keyanow, *Cree*	cami, *Tagala*; kami, *Malay*
	kenawun, *Natick*	gimowooa, *Tonga*
	mow, *Micmac*	mow, *Tonga*
	kistahnon, *Blackfoot*	kita, *Ponape*; keeta, *Malay*
	neyunow, *Cree*	naie, *Malagasy*
you	keyuwow, *Cree*	koe-ee-oo, *Malay*
	kenaau, *Natick*	kamo, *Tagala*; kamu, *Malay*
	kinawa, *Ojibbeway*	gimooa, *Tonga*
they	nahoh, *Natick*	now, "
	winawa, *Ojibbeway*	ginowooa, *Tonga*

Prepositions and Adverbs.

before	amooya, *Cree*	mua, *Tahiti*; gi-mooa, *Tonga*
		dee-mooea, *Malay*
below	utamik, *Cree*	atas, "
	chupuses, *Cree*; tabassish, *Ojibbeway*	da-baoua, "
behind	ootak, "	tooa, *Tonga*
near	tcik, *Algonquin*; cheke, *Cree*	dekat, *Malay*
at	kekek, *Cree*	ka, "
against, about concerning.	ooche, *Cree*	gi, *Tonga*

VOCABULARY OF MISCELLANEOUS TERMS.

Algonquin and Malay-Polynesian.

	Algonquin.	Malay-Polynesian.
all	misewa, mamo, *Cree*	man, *Tahiti*
alone	pikoo, *Cree*	be, *Tonga*
ant	ayik, "	kakai, *Amblaw*; osea, *Celebes*
arrow	kanouins, anwi, *Algonquin*	gnahow, *Tonga*
	wepema, *Miami*	pana, *Malay, Java*
	utoos, attouche, *Cree*	dota, *Ombay*
ashes	pekootao, *Cree*; pingwi, *Ojibbeway*	aptai, *Bouru*; aftuha, *Sula*
		kapok, *Galela*
awake	pakoonao, *Cree*	peekeeis, *Pelew*; bangou, *Malay*
axe	togkunk, *Algonquin*	togi, *Tonga*
	koksakin, *Blackfoot*	kisseem, *Pelew*
	agucwet, *Ojibbeway*	ikiti, *Batamerah*
basket	wutupewut, *Cree*	tampat, *Malay*
to be	itow, *Cree*	ada, *Malay*
belly	wachtey, *Delaware*	wutan, *Java*; butah, *Baju*
	mutai, *Cree*	motni, *Mysol*
bone	ochkunne, *Shawno*	koknatea, *Amblaw*
boat, canoe	wuskiwoose, *Cree*	wog, *Gani*; vaka, *Mariannes, Tonga*
	oot, *Cree*	oti, *Tidore*
	missole, *Miami*	mallayae, *Pelew*
body	eeio, *Ottawa*; yoa, *Ojibbeway*	aoh, *Menado*; awah, *Java*
	iniwia, *Blackfoot*	inawallah, *Saparua*; nanau, *Amblaw*
bow	uchape, *Cree*	jobi-jobi, *Tidore*; djub, *Sula*
bread, food	mechim, "	macunnan, *Malay*
	ayukoonow, *Cree*	kännon, *Bissayan*
	pummeh, *Mohican*	fafanga, *Tonga*
breast	totosh, *Ojibbeway*	tetai, *Malay*; toot, *Pelew*
bird	penasew, *Cree*	namo-bangou, *Tidore*
	pethesew, "	pitek, *Java* (fowl)
	benasew, *Ojibbeway*; pinasy, *Algonquin*	manok, *Java*, &c.

	Algonquin.	Malay-Polynesian.
brother	thetha, *Shawno*	taeae, *Tahiti*
	netahcan, *Mohican*	tuakana, *New Zealand*
	sayin, *Ottawa*	tehina, *Tonga*
	ounis, *Ojibbeway*	fonao, "
blue	kasqutch, *Cree*	kotteetow, *Pelew*
	chepatuk, "	ma-bida, *Menado*
break	pekoowayo, *Cree;* pikocko, *Algonquin*	fachi, *Tonga;* pata, *Malay*
bull	elapao, *Cree*	lomboo, *Malay*
blanket	ukoop, "	cafoo, *Tonga*
butterfly	kwakwapisew, *Cree*	kupukupu, *Malay;* kokop, *Teor*
brain	ootip, "	ooto, *Tonga;* eutac, *Malay*
bring	pacheweyao, "	baoua, *Malay*
broom	wapuhikun, "	sappoo, "
brush	siniku tukuhikun, *Cree*	seecat, "
clothes	equichtit, *Delaware;* weyachikuna, *Cree*	caguee, *Malay;* kakahu, *New Zealand*
cold	teu, "	toetoe, *Tahiti*
	teki, *Abenaki;* tegake, *Micmac*	tijok, diguin, *Malay*
chew	misemao, mamakwamao, *Cree*	mamah, *Malay;* mamma, *Tonga*
climb	ukoosew, *Cree*	caca, *Tonga*
cloth	munitooakin, *Cree*	gnatoo, "
comb	sekoohoon, "	cissar, *Malay*
crooked	wakisew, "	bico, *Tonga*
deer	hipasto, *Blackfoot*	paiow, *Baju*
die	nipew, *Cree*	pohi, *Tahiti*
dog	ayim, *Narragansett*	yem, *Mysol*
	anum, *Natick;* ahnem, *Ojibbeway*	anjing, *Malay*
	ameeteh, *Blackfoot*	muntoa, *Bouton*
deceit	wuyusehewawin, *Cree*	wahahee, *Sandwich*
	kukuyawisew "	kaka, *Tonga*
division	puska, "	vahe, "
dream	powamewin, *Cree;* kebahwahnon, *Ojib.*	menimbee, *Malay*
dry	pasoo, *Cree*	pau, *Tahiti*
earth	pockki, *Delaware*	buchit, *Malay;* pihta, *Rejang*
end	iswapewyoo, kisepao, *Cree*	abio, *Malay;* hopea, *Tahiti*
face	sisseguk, *Abenaki*	hihika, *Liang*
	mikwakun, *Cree*	muka, *Malay;* uwaka, *Morella*
	keelingeh, *Miami*	lugi, *Sula*
father	och, *Delaware*	uah, *Baju*
	ootawemow, *Cree*	tamai, *Tonga*
	meetungus, *Penobscot;* nootha, *Shawno*	moduah, *Sandwich;* medua, *Tahiti*
	ninnah, *Blackfoot*	nama, *Wahai*
fear	koostachew, *Cree*	coquet, *Malay*
	nunechewin, "	manuvache, *Tonga*
flesh	wiauthee, *Shawno*	waouti, *Awaiya*
	wonunya, *Arrapaho*	wamut, *Mysol*
	ojoos, *Delaware*	gusi, *Sanguir;* isi, *Baju*, &c.
fish	gigo, *Ojibbeway*	jugo, *Salayer;* iko, *Tonga*
	kinoosas, *Cree*	kena, *Sula;* ikan, *Malay*, &c.
forehead	hakulu, *Pennsylvania*	alis, *Malay*
fatigue	alaskoosew, *Cree*	lessoo, *Malay*
feather	oopewai, "	bushook, *Pelew;* bulu, *Malay*
to fly	pimeyow, "	boona, *Tonga*
finger	yeyokichichan, "	kakowana, *Sula*
	kinoochichan, "	kaniuke, *Mysol*
forefinger	itoohikun, "	toohoo, *Tonga*
flower	wapikwune, "	bunga, *Malay;* kembang, *Java*
flee	tupusew, "	sweebuk, *Pelew*
fight	masekao, "	mokamat, "
grass	muskoose, *Cree;* mijack, *Algonquin*	moochie, *Tonga*
grind	pinipooyao, *Cree*	tumboe, *Malay*
hair	lissis, *Ojibbeway*	low, *Tonga*
	milach, *Delaware*	uwoleihamo, *Awaiya*
	neleethe, *Shawno*	wultafun, *Teor*
		volundoha, *Malagasy*
	weehauknum, *Mohican*	wooko, *Bolanghitam*
heart	entahhee, *Miami*	yanton, *Malay*
	uteh, *Mohican*	ati, *Bugis*
heaven	heyring, *Shawno*	harani, *Sandwich*
hot	epekit, *Micmac;* kesipetai, *Passamaquoddy*	aputu, *Batamerah*, &c.
	kisisoo, *Cree*	sasahu, *Tidore*
house	opee, *Shawno*	abi, *Tonga*
	muyai, *Blackfoot*	umah, *Java*
hate	pukwatao, *Cree*	benkee, *Malay*
hard	muskowisew, "	maketihy, *Celebes*, &c.

	Algonquin.	Malay-Polynesian.
iron	pewapisk, *Cree*	busi, *Malay*, &c.
if	keepin, *Cree*	capow, *Tonga*
insect	munichoos, *Cree*	monga-monga, *Tonga*
island	ministik, *Cree*; minnis, *Ojibbeway*	nusa, *Bouru*, *Amboyna*, &c.
journey	pupamatisewin, *Cree*	fononga, *Tonga*
kindle	kwakootao, *Cree*	cacaha, "
knife	mokoman, *Ojibbeway*	macouosim, *Alfuros*
	sapapistacis, *Blackfoot*	pisau, *Malay*
lizard	oosikeyas, *Cree*	kihia, "
load (a canoe)	poosehao, "	fowagi, *Tonga*
louse	ikwa, "	okuta, *Bouton*
love	sakehao, "	souka, *Malay*
mat	anakan, *Ojibbeway*	junguto, *Galela*
morning	wapua, *Cree*	popongi, *Raratonga*
mosquito	sukimao, *Cree*	sugeti, *Bouru*; gumoma, *Galela*
mother	mikawe, "	mako, *Baju*
	ningah, *Miami*	inungi, *Sanguir*
	nana, *Potawatomi*	inana, *Bouton*
	niwa, *Shawno*	nafa, *Tonga*
mountain	wahchiwi, *Shawno*	vohita, *Malagasy*
mouse	apikoosea, *Cree*	bokoti, *Bouton* (rat)
much	ayewak, "	peepack, *Pelew*
neck	kwegan, *Algonquin*; ohkokin, *Blackfoot*	kaki, *New Zealand*
	oquiow, *Cree*	guya, *Tonga*
name	issenikasoowin, *Cree*	hingoa, *Tonga*
	weloowin, *Cree*	gnalan, *Tagala*
	weroowin, "	pouranama, *Malay*
navel	mitise, "	bito, *Tonga*
nail (finger)	okanj, *Algonquin*	kanuko, *Celebes*
	miskuse, *Cree*	kuku, *Malay*
nut	pukan, "	pooo, *Pelew*; beequee, *Malay*
odour	meyamao, "	namoo, *Tonga*
oil	memaye, *Micmac*	mineac, *Malay*
	pemmee, *Abenaki*; pime, *Cree*	fango, *Tonga*
open	pasketa, *Cree*	buca, *Malay*
pinch	chestipatao, *Cree*	tchoubat, *Malay*
pass	pasich, *Cree*	piko, *Malay*
partake (portion)	puke, "	baguee, *Malay*
paddle	upwoi, "	fohe, *Tonga*; pagayo, *Malay*
plenty	mistuhe, "	mataud, *Malay*
	mechatew, *Cree*	maka, *New Zealand*
prosperity	meyooayawin, *Cree*	mooona, *Tonga*
to place	ayao, "	y, "
plain	mitoone, "	tonoo, "
peel	petoopitao, "	fohifohi, "
quiet	kelamisew, "	lolongo, "
river	sibi, *Ojibbeway*	sawan, *Sanguir*; uve, *Bouton*
ring	uchunis, *Cree*	tchintchin, *Malay*
rise	wuniskow, *Cree*	bangou, "
rod	seskuhoon, "	seeca, "
rub	sisoonao, "	gosso, "
reckon	itayetum, "	eeton, "
remnant	pewipichekun, *Cree*	lebignan, "
road	mikana, *Ojibbeway*	neko, *Galela*
root	wutupe, *Cree*	tefito, *Tonga*
sit	oonupew, "	nofo, "
serpent	kenabeg, *Ojibbeway*	nife, *Amblaw*; pok, *Mysol*
skin	wusukai, *Cree*	pisi, *Menado*; usa, *Lariki*
	utai, "	kutai, *Saparua*
	wian, *Algonquin*	unin, *Wahai*
star	ahnungoon, *Ojibbeway*	kingkong, *Timbora*
	watawesu, *Abenaki*	fetoo, *Tonga*; tahwettu, *Tahiti*
	alangua, *Miami*	alanmatana, *Batamerah*
	alank, *Ojibbeway*; alaqua, *Shawno*	lintang, *Java*; meleno, *Teluti*
	attack, *Cree*	abbthduk, *Pelew*
	anang, *Algonquin*	oona, *Awaiya*
stone	wudju, *Ojibbeway*	bahtu, *Bugis*
	penapse, *Abenaki*	papa, *Tahiti*
sword	simakun, *Cree*	songai, *Batta*
sing	nikumoo, "	migniaguee, *Malay*
smoke	ukwapatao, *Cree*	acep, "
sleep	nebat, *Micmac*	moopat, *Pelew*
stink	wechakisew, *Cree*	boussouc, *Malay*
suck	soosoopemao, "	tioup, "

	ALGONQUIN.	MALAY-POLYNESIAN.
sure	kachenahoo, *Cree*	songoo, *Malay*
swear	uspimoo, "	soumpan, "
sweep	wapuwao, "	sappou, "
spear	usimakun, "	sanoko, *Camarian*
	takuchikun, "	tuwaki, *Amblaw*
soft	munookow, "	musikomi, *Sanguir*
sour	sewisew, "	assam, *Malay*
salt	sewetakun, *Cree;* ciwitagun, *Algonquin*	simuto, *Bolanghitam*
soul	achak, *Cree*	aho, *Tahiti*
squint	utitapew, *Cree*	tepa, *Tonga*
strong	sepisew, "	fefeca, "
strike	ootamuwao, *Cree*	ta, toogi, *Tonga*
tree	abassi, *Abenaki;* apass, *Passamaquoddy*	pohoo, *Malay;* bougo, *Tonga*
to-morrow	wapuke, *Cree*	bass, *Malay;* bongi-bongi, *Tonga*
throw	pimoosinao, *Cree*	bomgeetee, *Pelew*
tail	oosoo, "	igoo, *Tonga*
thoughtful	mamitoonayetum, *Cree*	manatoo-natoo, *Tonga*
turtle	mikinak, "	pignoo, *Malay*
unlucky	malookoosew, "	malaia, *Tonga*
water	bi, *Delaware;* bij, *Pennsylvania*	boi, *Baju;* vai, *New Zealand*
	sipe, abo, *Ojibbeway*	pape, *Tahiti;* evi, *Easter*
	ohkeah, *Blackfoot*	akei, *Menado*
	orenpeoe, *Souriquois*	rano, *Malagasy*
wind	notin, *Algonquin*	matangin, *Tonga*
	awaunwee, *Miami*	anguin, *Malay*
well (adverb)	meyoo, *Cree*	behai, "
where	tanewa, "	deemana, *Malay*
workman	ootutooskao, *Cree*	toucan, "
write	ojibiige, *Ojibbeway*	papai, *Tahiti*
wing	ootutukoon, *Cree*	ihoti, *Amboyna,* &c.
work	aputisew, "	petchiol, *Mal.;* faatuba, *Tonga*
walk	ecoonne, *Blackfoot*	hahani, *Tahiti*
a well	walipayan, *Cree*	lepa, *Tonga*

CONTRIBUTIONS TO AMERICAN HELMINTHOLOGY.

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No. 1.

The observations recorded in the following pages were made for the most part during the months of September and October of the present year. Teaching duties have, however, prevented the completion of many of them; and it is only in consideration of the difficulty of procuring, during the winter, fresh material with which these might be supplemented, and of the fact that certain other interesting forms (which I hope shortly to describe to the Institute) have recently engaged my attention, that I publish these notes in their present fragmentary condition.

The work was undertaken with the desire of contributing towards a wider knowledge of the anatomy of Trematodes. In the attempt, however, to diagnose the forms that presented themselves for examination, it became apparent that in spite of the extensive contributions of Dr. Joseph Leidy, much work of a faunistic character remains to be done in this department on this continent.

The present paper has assumed in this way more of a systematic character than was originally intended; although there are, it is hoped, some points of interest to the general zoologist.

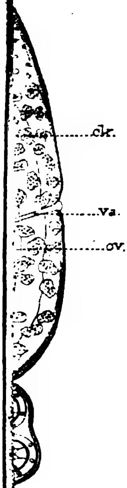
Certain important memoirs are not accessible to me here; owing to which there are, no doubt, misstatements or omissions which might otherwise have been rectified.

TREMATODES.

1st Sub-Order—Digenea. Van Ben.

1.—Distomum heterostomum. *Rud.*

I refer provisionally to this species certain worms which I have found on two occasions firmly adhering to the mucous membrane



6.

Fig. 10. × 166

Fig. 11.

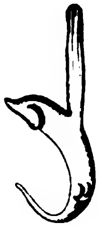


Fig. 13. × 138.

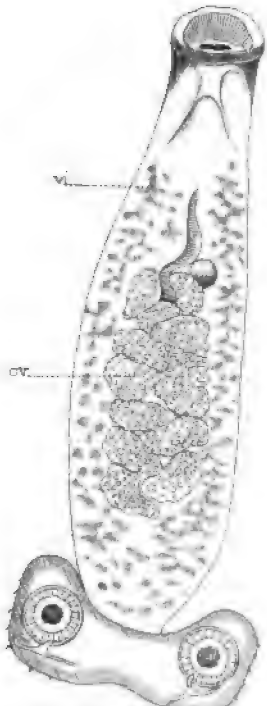


Fig. 12. × 30.

Copp, Clark & Co. Lith. Toronto.

of the mouth of the American Bittern (Botaurus minor, Gm.) at the sides of and below the tongue.

The following species, according to V. Linstow's excellent "Compendium," have been found in the cavity of the mouth or in the œsophagus of Ciconiæ:

1.	D. complantaum	œsoph	Ardea cinerea.
2.	D. heterostomum	sub lingua	A. purpurea.
3.	D. hians	œsoph	Cic. alba.
4.	D. dimorphum	"	A. cocoi.

These forms are closely related; indeed, Dujardin[1] regards the first two as identical with the third, and Diesing[2] seems to suggest that the first and fourth are also related. The separation by Diesing of D. hians from these congeners, on account of the relative size of the suckers, may possibly be grounded on a mistake. The anterior end of the worm which I possess resembles closely that of D. dimorphum (see Diesing's figure),[3] and it is more than probable that the prominent border which surrounds the mouth in these forms has been taken for the anterior sucker. This it seems to replace functionally in part in my specimens; for during life it undergoes rapid changes in shape, sometimes having a circular sometimes a triangular aperture, and plays an active part in the locomotion of the animal; while the anterior sucker is quite distinct, although small, and is immersed in the papilla which springs from the anterior depression. (See Fig. 1).

The following points in the description of D. heterostomum induce me to refer my specimens to it until a comparison can be made: the habitat, size, *two lateral lines*, form of anterior end of body, of neck and of ventral sucker, position of genital organs and apertures.

The details which follow are for the most part taken from dead specimens.

The form of the body is subject to much variation. Fig. 1 represents it at rest. Length, 6.85 mm.; greatest breadth, 1.5 mm. It may, however, lengthen into a much more linear form. The anterior sucker is 0.3 mm. in diameter, its aperture transversely elliptical. The pharynx has thin walls, is still smaller, and gives off the intestinal coeca immediately, which are very conspicuous from the deep brown pigment in their walls. They have the further peculiarity of

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[1] Helminthes, p. 399. [2] System. Helm. I. 354.
[3] Neunzehn Arten Tremat. X. B. Denkschr. d. k. Akad. in Wien., Taf. III., 2 & 3.

being provided on each side, at any rate in the trunk, with short, sometimes branched, diverticula (Fig. 2), which, however, project much less in the most extended condition of the animal. This character seems to be shared by D. dimorphum,[4] and although present in many Polystomeæ (Epibdella, Diplozoon, Onchocotyle, &c.), is by no means common in Distomeæ.[5]

The ventral sucker is situated 0.8 mm. behind the anterior, and is 0.8 mm. in diameter. Its cavity is deep and gaping during life; frequently its orifice is circular from strong contraction of the radial fibres, usually *shield-shaped* or triangular.

The excretory system has a large caudal pore, and two much convoluted lateral stems, which run along the sides to the neck. During life I observed that the granules contained in these also circulated through the vacuolated parenchyma of the body, although they did not seem to enter the plexus of fine canals which could be seen immediately under the outermost investment. The parenchyma reminded me of that which I have myself observed, and which has been described by Fol and others, in the foot of embryonic Gastropods. This connection between water-vascular system and parenchyma spaces has been insisted on by Sedgwick Minot.[6]

I have not been able to follow satisfactorily all of the genital organs. The vitellogens (see Fig. 1) are in the form of racemose glands grouped round the intestinal coeca, and occupying the interval between these at the hinder end of the body. The testes (*t*) are two in number, and between them are the ovary, first convolutions of the oviduct, and a retort-shaped receptaculum seminis, from which I am inclined to believe a canal (vagina?) passes upwards towards the back, although I have failed to detect this in my preserved specimens. Towards the right side of the anterior testis is a structure whose function I have not been able to determine. It is possibly the thickened end of the oviduct at its junction with the uterus; at any rate the thickened tube projects into the bottom of the thin walled uterus, and is subject to a regular and slow evagination of the anterior part of its inner surface, recalling the gradual eversion of the peristome in a Vorticella. This is followed by a rapid retrac-

[4] Diesing's fig., loc. cit.

[5] Schmarda, Zoologie, attributes this character to D. cygnoides and clavigerum of the Frog; Pagenstecher's figures (Trematodenlarven und Trematoden) do not corroborate this.

[6] On Distomum crassicolle. Mem. Bost. Soc. N. H., Vol. III., p. 5.

tion. It may be similar to the "Schluck-œffnung" observed by Vogt in certain marine Trematodes.[7]

The genital orifice, as in D. dimorphum, is situated behind the ventral sucker about 1 mm. No cirrus was detected. The oval eggs have a thickish yellow shell, with a lid at the narrow end, and measure 0.099 mm. by 0.066 mm.

2.—DISTOMUM ASPERUM, *n. sp.*

One of the two examples of Botaurus minor above referred to yielded ten specimens of a Distome occupying two varicose dilatations of the bile-duct, recalling the swollen bile-ducts described by Cobbold[8] in a Porpoise. The worms proved to belong to Dujardin's sub-genus Echinostoma; and I at first believed that they might be D. ferox, Zeder, first detected by Goeze in dilated intestinal follicles of Ardea stellaris. I was more inclined to do so from discrepancies in the various descriptions of this form.[9] Certain peculiarities, however, seem to me to mark it off from that species, of which it is undoubtedly a near relative, and I accordingly propose the specific name "asperum" for my specimens.

> DESCRIPTION (Figs. 3, 4, 5).—Body yellowish white, 8.19 mm. long, 1.8 mm. broad in middle, *tapering gradually to each end;* the head and *anterior part of neck narrower* than tail; covered *entirely* with *persistent* spines 0.054 mm. long, somewhat sparse posteriorly; head reniform, with a coronet of 27 *obtusely-pointed* spines, four of which on each side of a median ventral notch are larger (0.155—0.16 mm.) than the others (0.117 mm.), and *radiate from nearly a common point of origin;* anterior sucker terminal, with projecting circular lip 0.14 mm. in diam.; ventral large (0.75 mm.), situated *at junction of anterior and middle thirds of body.* Vitelligenous glands chiefly in neck, but accompanying intestinal coeca to posterior end.

The orbicular neck of D. ferox, its deciduous spines only present anteriorly, the position of its ventral sucker, and the constriction of the body there, together with the arrangement of the coronal spines, seem to distinguish it effectually from D. asperum.[10] The genital

[7] Zeit. f. Wiss. Zool., B. XXX., Suppl., p. 307, f.

[8] Jour. Linn. Soc. XIII., p. 39.

[9] For lit. *see* Dies. Syst. I., p. 387; Molin. Denkschr. d. k. Akad in Wien XIX., p. 219; Olsson, Kongl. Svensk. Vetensk. Akad. Handlingar. XIV., p. 22. I have not access to Van Beneden's paper, "Sur la cicogne blanche et ses parasites." Bull. Acad. Belg. XXV.

[10] Cf. Fig. 4 with Olsson's Fig. 50 loc. cit.; also V. Linstow's descr. Trosch. Archiv., 1873, p. 106, and Dujardin's.

organs answer well to Olsson's description of D. ferox; the eggs, however, measure 0.096 mm. × 0.069 mm., while the following are measurements given for D. ferox:

0.092 – 0.102 mm. × .049 mm. (Dujardin).
0.06 mm. × 0.04 mm. (Olsson).

The penis, exserted in all my specimens, is smooth, and measures about 2 mm. in length.

The pharynx is pistilliform; the intestine bifurcates 2.08 mm. from the anterior end, and is very easily distinguishable from its dark brown contents (probably broken down epithelium and blood corpuscles).

3.—DISTOMUM RETICULATUM, *n. sp.*

The Assistant Curator of the University Museum, while preparing a specimen of the Belted Kingfisher (Ceryle alcyon, Boie) in April, found two Trematode worms "on the surface of the lung," which present in many respects a remarkable resemblance to D. hepaticum, L. I believe them to be hitherto undescribed, and I propose for them the specific name "reticulatum," referring to the beautiful network formed by the branching and anastomosing testicular tubes shining through the translucent testicular area.

DESCRIPTION (Fig. 6).—Body *ovate*, flat, or slightly concave ventrally, separated by a constriction and by a *large and projecting* acetabulum from the *upturned* neck. Total length, 14 mm.; greatest breadth, 8 mm. Entirely covered with recurved *rounded 0.025 mm. long* spines, which are closer and smaller on anterior part of neck. Anterior sucker bowl-shaped, 0.9 mm. wide. Acetabulum 1.3 mm. diameter, orifice circular. Pharynx oval, thick-walled, 0.48 mm. wide. Intestinal coeca *unbranched* (?). Bifurcation shortly behind pharynx. Genital orifice immediately in front of acetabulum. Penis (?). Uterine gyri overlying and extending behind the acetabulum. Testes, in the form of branched tubes, occupying a translucent *oval* area, with black borders *narrower posteriorly*, formed by the vitelligenous glands, which are disposed in a racemose manner round a dorsal and a ventral longitudinal stem on each side. Eggs average 0.11 mm. × 0.065 mm.

The above description contains most of the points which can be observed by studying this worm entire by the aid of a compressorium. Probably slicing will give better results as to the disposition of the genital apparatus and intestinal coeca. The ease with which the

intestine can be made out in D. hepaticum depends entirely on the dark contents: the bifurcation was here observed from the dorsal surface, but the branches were empty. The longitudinal muscular fibres are strongly developed on the ventral surface, and the ventral surface of the neck has two sets of oblique decussating fibres, as in D. hepaticum.[11] The transverse vitello-duct can be easily seen with the naked eye. The right half is longer than the left, and the common duct, leading obliquely upwards (towards an Ootype ?), is narrower than either.

4.—DISTOMUM VARIEGATUM. *Rud.*

In looking for Polystomum-eggs from a specimen of Rana halecina, Kalm, in the way recommended by Zeller,[12] I found that a worm had been voided by the frog, which turned out to be D. variegatum, Rud. It had been partly macerated from exposure to the water; the acetabulum was consequently even more than ordinarily difficult to make out, and the characteristic coloration was destroyed. The application of picrocarminate, however, is particularly successful in rendering distinct the different organs in Trematodes, and probably more so in such a case as this from the previous bleaching.[13]

The intestinal coeca were entirely destitute of contents, and their epithelial lining (average individual cells of which [Fig. 7] measured superficially 0.03 mm. × 0.021 mm.) was well seen.

The left lung of the same animal yielded only one well-coloured example of the worm.

My examples agree well with Pagenstecher's description and measurements,[14] except that the ventral sucker was easily discoverable in the fresh worm, and that the testes, three in number, which seemed to be composed of flask-shaped cells empty of their contents, and with the neck of the flasks converging to the vas deferens, could hardly be called small. The vitelligenous glands, as Blanchard has already figured,[15] are in the form of six or seven scattered racemose clumps on each side, with a connecting longitudinal stem.

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[11] Leuck. Mensch. Par., I., 537.

[12] Zeit. fur. wiss. Zool. XXVII., p. 255, f. n.

[13] After writing the above, I notice that the use of picrocarminate has been already recommended by Dr. G. Duchamp (Journal de Micrographie, July, 1878).

[14] Trematodenlarven und Trematoden, p. 41.

[15] Ann. des Sci. Nat. 3 S. VIII., Pl. 13, f. 1.

5.—Distomum gracile. *Diesing.*
  Clinostomum gracile. *Leidy.*

This worm was first described by Dr. Leidy,[16] who regarded it as generically different from Distomum. He records it from the intestines of a Pike, and from cysts in the gills, fins and muscles of Pomotis vulgaris (auritus), Günther. I have found the same worm in cysts on the branchiostegal membrane and anterior fins of Perca flavescens, Cuv. This species appears to me to belong to the same group as D. heterostomum and D. dimorphum, from the structure of the anterior end, and of the ventral sucker. In a specimen of 6.45 mm. in length, with a greatest breadth of 1.8 mm. across, the mouth sucker measures 0.338 mm. across, and the prominent border which surrounds it 0.975 mm. The large ventral sucker (0.91 mm.) is situated in the middle of a constriction dividing the neck from the body, and has a triangular aperture. Its cavity is lessened by three triangular tongues, which project into it so as nearly to meet each other. The anterior of these points with its apex backwards; all are formed chiefly of radial fibres, and they must undoubtedly increase the efficiency of the sucking apparatus very considerably.

The species of Distomum which have been found included in cysts are either fully mature (D. agamos, V. Linst.,[17] D. Okenii, Köll., D. crassicolle, R. [Pontallié]), or have only one part of the sexual apparatus ripe (D. hystrix., Dujard., the testes[18]), or are finally quite immature. In the last category fall D. annuligerum, Nordm., D. diffusocalciferum, Gastaldi, D. dimorphum, Diesing, and, as I believe, D. gracile. No mention of generative organs is made in Leidy's description, and I have failed to detect any trace of such. The Sunfish and Perch can consequently hardly be regarded as the definitive hosts of this worm. Probably the sexually mature worm is to be sought for in the intestine of some larger fish (Pike?) or piscivorous bird. In the latter case, the relationship between the immature and mature form would resemble the two forms of D. dimorphum described by Diesing.

The intestinal coeca are large, and extend nearly to the posterior end; the contents are yellowish-brown, and include some lozenge-shaped concretions.

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[16] Proc. Ac. Sci. Phil. VIII., p. 45.
[17] Trosch. Arch. XXXVIII., B. I., p. 1, f.
[18] Olsson, Lund's Univers. Årsskr. IV., p. 52.

Plate II.

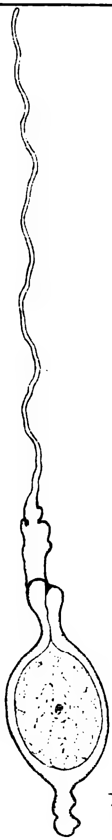

Fig. 22.

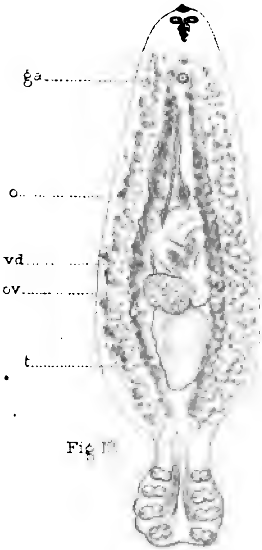

Fig. 19.

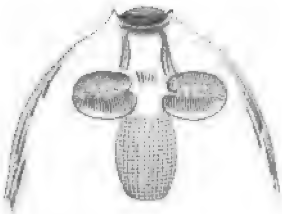

Fig. 20.

Fig. 21.

R.R.W. del.t

Copp, Clark & Co. Lith Toronto.

The water-vascular system has a wide median stem, which continues from the caudal pore half way to the ventral sucker, giving off in its course lateral branches, which communicate with the finer canals of the system. One of my specimens, which had been preserved in alcohol, was placed in a diluted carmine solution resembling Beale's, but the fluid, instead of staining the tissues to any extent, entered the water-vascular stem and injected the subcuticular meshwork, resulting in a beautiful preparation resembling the actual injections from which Blanchard's figures of the water-vascular system in various Trematodes are taken.[19] Rounded calcareous corpuscles occurred in great numbers in the median stem and its primary branches; these seem to be especially abundant in immature Trematodes.

On the ventral surface behind the acetabulum were several series of dark granular spots—perhaps the optical expression of cutaneous glands.

2ND SUB-ORDER—MONOGENEA. VAN BEN.

1.—OCTOBOTHRIUM SAGITTATUM. *F. S. Leuck.*
PLACOPLECTANUM SAGITTATUM. *Diesing.*

I possess several specimens of a worm from the gills of one of our fresh water fishes here, probably Catostomus teres, Le S., which were, unfortunately, preserved without any label, and as to the habitat of which I am consequently uncertain.

A comparison of Fig. 19, Pl. II., with Leuckart's figure of Octobothrium sagittatum,[20] will show the great similarity between the appearance of the worms. I cannot reconcile certain points in his description with what I have ascertained from these specimens; but I propose to refer to these provisionally under this heading until I have access to a more satisfactory description of the worm living on the gills of the European brook trout, and until I secure fresh specimens of the form taken here.

The body is arrow-shaped, 6 mm. in length, with a greatest breadth of 1.5 mm. The body is separated by a marked constriction from the caudal disc, which is notched posteriorly, and has four suckers on each side of its ventral face.

The structure of these suckers is at variance with Leuckart's description. It is with great difficulty that one can succeed in getting a satisfactory view of the chitinous framework, under a cover glass,

[19] Loc. cit., Pls. IX. and X.
[20] Zoolog. Bruchstücke, III., Taf. V.

without distorting some part of it. The only way to obtain a correct view of the structure of the suckers, is to examine them in the first place with incident light before they have been subjected to pressure. I believe that Fig. 8 conveys a correct interpretation of the disposition of the parts of the framework.

The suckers have short muscular pedicels and an oval aperture, the long axis of which is directed transversely to the caudal disc, and which has a nearly continuous chitinous ring. This ring is interrupted by hinges at four points in its course, viz., the middle points of the outer and inner borders, from each of which a hook arches over the aperture of the sucker, and the middle points of the anterior and posterior borders, where it meets with a mesial piece which traverses the concave floor of the sucker. I have never been able to establish the continuity of this with the anterior border of the ring, and am inclined to believe that they do not meet.

The aperture of the sucker may be narrowed so as only to leave a chink between its approximated anterior and posterior borders. This is effected by the outer and inner hinges, and the appearance of the framework is changed by the greater curvature thus given to the mesial piece, and by the free hooks being pressed backwards toward the posterior border. I believe that Leuckart's figure is drawn from the framework in this position; in which case it is possible to identify the pieces shown in both figures.

The aperture of the sucker may also be narrowed in a direction at right angles to the above, in which case the hinges from which the free hooks project become more apparent. This seems to agree better with Olsson's figures (loc. cit.) of the suckers in various species of Octobothrium.

The mouth-suckers are somewhat peculiarly formed, the muscular tissue being interrupted at the inner margin of each (Fig. 20, Pl. II.).

The intestinal coeca are invested throughout by a thick layer of vitelligenous glands, forming two dark-coloured stripes in the body, on each side of and between which a somewhat more translucent area is to be seen.

The abundance and opacity of these glands render the examination of the genital organs difficult; the following points were, however, made out.

The only genital orifice detected is situated 0.78 mm. from the anterior end. It is a circular sucker of 0.135 mm. diameter, which,

when viewed superficially, shows radial fibres and an irregular quadrangular orifice; but when the glass is pushed deeper, shows a doubly contoured ring 0.0135 mm. diameter, surrounded by circular fibres. (Fig. 21.) The ovary is somewhat bilobed, the ovarian eggs are polygonal from mutual pressure, and measure 0.009 mm. The fully formed egg differs much from Leuckart's figure, and approaches those described by Olsson for various species of Octobothrium. Its oval body measures 0.195 mm. in length, while the whole egg is 1.04 mm. long. (Fig. 22.)

The testis lies behind the ovary, and its vas deferens, surrounded by strong circular fibres, is continued forwards near the dorsal surface of the body. It probably opens by the same aperture as the oviduct; at any rate, I have not been able to detect any trace of a second genital aperture.

2.—POLYSTOMUM OBLONGUM, *n. sp.*

In September I had the opportunity of dissecting a single specimen of the Musk Turtle (Aromochelys [Sternothaerus] odoratus, Gray): the only parasites obtained from it were four examples of an undescribed species of Polystomum found in the urinary bladder. No Helminths, as far as I am aware, have been hitherto obtained from this organ in Chelonia; the fact, however, that P. ocellatum is described from the cavity of the mouth in two Old World Turtles, suggested to me that I had perhaps in these a bladder stage of that worm, and that the two known species of Polystomum had in this way a precisely parallel history.[21] A closer examination and comparison with the characters of the two described species, showed that the worms presented peculiarities of specific value. I hope shortly to have the opportunity of examining the other turtles (Chrysemys picta, Chelydra serpentina) which are common in this neighbourhood, and have no doubt that Polystomes will be found in the oral cavity as well. An examination of the urinary bladder of Emys Europaea might not be without results in this respect.

DESCRIPTION (Figs. 9, 10. 11).—Body oblong, mouth on the *ventral* surface of the *rounded* anterior end. Pharynx bowl-shaped. Intestinal coeca *without anastomoses or branches.* Generative outlets *in front of the line* of the lateral vaginæ. Cirrus-coronet of *sixteen alternately small and large sabre-shaped pieces. Viviparous.* Length up to 2.5 mm., breadth to 1.5 mm. Egg, greenish, 0.235 mm. × 0.195 mm. Larva ocellate 0.5 mm. in length.

[21] For life-history of P. integerrimum, *v.* Zeller. Zeit. wiss. Zool. XXVII., p. 238 f.

The general outline of the body is somewhat oblong when the worm is at rest; in motion, however, its form is capable of considerable variation, and it is especially then that the constriction corresponding to the position of Zeller's "Seitenwülste" is noticeable. The caudal lamina is somewhat narrower than the greatest width of the body, and is shorter than it is broad. The body narrows considerably at its junction with the caudal lamina.

The hooks and suckers are disposed very much as in P. integerrimum. The suckers (0.2 mm. in diameter) seem to project rather more than in that species, and their prominent rim bears a series of rounded apertures similar to those spoken of above in describing the suckers of Octobothrium sagittatum. The smaller hooks (Fig. 11) measure 0.015 mm. in length. The six anterior of these are situated in pairs between the two anterior suckers. They have a knobbed attached end, with an arm (longer than represented in the figure) projecting at right angles not far from the middle of the hook. The four posterior (situated between the larger hooks) are capable of more independent action than the others. This was evident when the worm endeavoured to free itself from the piece of thin glass by which it was covered. The two large hooks measure 0.15 mm., and have a proportionately deeper notch than those of P. integerrimum.[22]

No eye-spots were observed in the adult worm. The longitudinal system of muscular fibres seemed to be most developed.

The mouth is transversely oval, and is surrounded by a well-marked sucker, in which radial and vertical fibres preponderate. It leads immediately into a bowl-shaped pharynx, the walls of which possess merely weak circular fibres, and from this the simple intestinal coeca arch backwards directly. The coeca of all the observed specimens were empty.

Only the convoluted lateral stems of the water-vascular system were observed near the anterior end.

The lobes of the vitellogen are more scattered than in P. integerrimum, and do not extend into the caudal lamina. The transverse duct seemed to pass inwards dorsally from the intestinal coeca; but I have been unable to determine the relationship of the internal generative organs, partly from the fact that my specimens were taken from the turtle the day after it was killed, and consequently had very little vitality.

[22] Cf. Zeller, loc. cit., Taf. XVII. p. 12.

The testis is a solid gland situated in the posterior third of the body. The course of the vas deferens is shown in the figure. No internal vas deferens was observed. The male outlet lies immediately behind the bifurcation of the intestine, and is armed with sixteen alternately large and small hooks, which differ considerably in form from those of P. integerrimum. The free end of each piece is sharply curved; the attached end is shaped like a cross, the transverse piece of which is longer on one side than the other. The longer pieces measure 0.02 mm., and the shorter ones 0.015 mm. Whether there is any connection between the attached ends, I am unable to say.

The comparative transparency of the body would render the examination of the internal organs of this species of Polystomum particularly easy. I failed, however, to satisfy myself as to their disposition, from the cause noted above.

As in P. integerrimum, there are two lateral cushions, in this case each situated in a depression, which communicate with canals (vaginæ) leading towards the middle of the body. The inner ends of these I could not follow. A third canal, originating from an oval body with brown contents (shell-gland ?), situated on the left side of the middle line (*ov*, Fig. 9), likewise was observed to take the same direction. The ovary (not represented in the figure) is situated in front of the testis on the right side of the body. The short oviduct terminates in a wide uterus, in which only a single egg can be accommodated at one time. The egg-shell is somewhat thin, is destitute of the short stump present in that of P. integerrimum, but has a rather large operculum.

In each of the two most active specimens of the worm which I secured, a Gyrodactylus-like larva, similar to that of P. integerrimum, and with eye-spots disposed in the same fashion, had already escaped from the shell, and was moving actively within the uterine chamber.[23] The motions seemed to depend entirely on the muscles and the hooks of the caudal disc. This had a rounded outline, except posteriorly, where there was a square projection bearing the four posterior small hooks. The disc measured 0.114 mm. across, and the twelve anterior

[23] According to Zeller (loc. cit., p. 269, note), "die Eier bei den jüngsten fortpflanzungsfähigen Harnblasenpolystomen durchmachen ihre Entwickelung noch innerhalb des Eierleiters." I am not sure whether to conclude from this that, as in the present instance, larva and egg-shell are extruded separately from the uterus. I am inclined to believe, however, taking into consideration the size and advanced state of development of the larva, the absence of cilia, and the thinness of the egg-shell, that this viviparous method is the normal in P. oblongum.

small hooks were disposed at regular intervals on the margin of the rounded part of the disc. There was no trace of suckers. The small hooks had already attained their definitive size and form; the two large ones, on the other hand, situated considerably further in from the margin than in the adult, measured only 0.024 mm. instead of 0.15 mm. This difference in length is owing to the shortness of the immersed portion, in which, however, the notch is already formed.

It will be seen that in respect of the state of development of the large caudal hooks, this larva differs considerably from that of P. integerrimum. It is also larger, measuring 0.5 mm. in length, instead of 0.3 mm.

SPHYRANURA OSLERI, *nov. gen. et spec.*

I have lately received from my friend Professor Osler, of Montreal, several specimens of a worm taken from the gills and cavity of the mouth of our common Lake-Lizard (Necturus [Menobranchus] lateralis, Raf.) These had been preserved for eight years in Goadby's fluid, and proved comparatively useless for further examination, having become quite opaque and black in colour. From some specimens, in a good state of preservation, mounted by Dr. Osler for microscopical examination, and also from his notes and sketches made on observation of the fresh specimens, I am able to communicate the following. The only specimen of Necturus which I have had the opportunity of examining since receiving these did not yield any of the worms.

According to Diesing's conspectus (Revision der Myzhelminthen), the worms ought to fall into his genus Diplectanum. I have not access to Wagener's later descriptions of the two species of this genus. It is evident, however, from a study of Van Beneden's[24] and Vogt's[25] figures and descriptions of D. æquans, that this form cannot be referred to Diplectanum. It resembles Polystomum, and differs from Dactylogyrus and Diplectanum in the following points: (1) The size and shape of the egg; (2) the structure of the suckers; (3) the disposition and number of the caudal hooks. It differs from Polystomum in the general form, the number of suckers, and the structure of the

[24] Rech. sur les Trémat. marins, p. 122, Pl. XIII.
[25] Zeit. für wiss. Zool., Suppl. XXX., Taf. XIV. 2, XVI. 1.

genital apparatus, and I propose for its reception the generic name "Sphyranura," with the following characters:

> Body depressed, somewhat elongate, expanded posteriorly into a caudal lamina, *considerably wider* than the body, bearing *two* immersed acetabula, two large hooks behind these, and sixteen small hooks (seven along each side of the lamina, and one in the centre of each acetabulum). Mouth ventral anterior, somewhat funnel-shaped, intestine with two branches anastomosing posteriorly. Excretory pore between the acetabula, *two contractile bladders anteriorly.* Oviparous. Parasitic on the gills and in the mouth of perennibranchiate Amphibia.

The specific characters in the allied genera are derived chiefly from the size, the caudal and genital armature, and the size and shape of the eggs. I accordingly note the following as characteristic of this species, which I propose to associate with the name of Dr. Osler as S. Osleri, *n. sp.* (Figs. 12, 13, 14.)

> Body 2.6 mm. in length by 0.7 mm. in breadth, narrowed at each end, especially where it joins the caudal lamina, which measures 1 mm. across, and about 0.45 mm. in length. Large hooks 0.2 mm. long. Oviduct occupying the interval between the intestinal coeca, with numerous eggs; uterus with single mature egg, oval, with brownish-yellow shell, 0.364 mm. × 0.247 mm.

I am not aware that any monogeneous Trematode, with the exception of Polystomum integerrimum, has been hitherto found in any amphibian; and this seems to be restricted to the tailless forms. A careful examination of the gills, mouth-cavity, and urinary bladder of both perennibranchiate and caducibranchiate Urodela would probably yield interesting results with regard to this family of Trematodes.

I regard the form under consideration as of great interest in view of the frequently asserted[26] relationship between Dactylogyrus and Gyrodactylus on the one hand, and Polystomum on the other, and I propose to recur to this after detailing the facts which I have been able to elucidate with the material at my disposal.

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[26] Von Siebold, Untersuchungen über Gyrodactylus. Van Beneden, Animal Parasites, Eng. Ed., p. 261. Willemoes-Suhm, Zeit. f. wiss. Zool. XXI. I have not seen this paper. The following is from Hofmann und Schwalbe's Jahresberichte für 1872, p. 274: "Hat Zeller den Lebenslauf der Thiere vorzüglich aufgeklärt so gebührt Willemoes-Suhm die Priorität der Publicirung der Beschreibung der Larve, sowie die Andeutung, dass die Aehnlichkeit derselben mit einem *Gyrodactylus* eine phylogenetische Entwickelung von *Polystomum* und *Gyrodactylus* aus einer Stammform wahrscheinlich mache."

The measurements on Fig. 12 are taken from a specimen in which the eggs are nearly ripe. The worm somewhat resembles a hammer in shape, the body forming the shaft of the hammer and the tail-piece the head. This resemblance is greater in the hardly-mature specimens, where the oviduct is not dilated with eggs, and the body consequently more linear in outline.

The caudal lamina is considerably wider than the body. It is longest at each side, and somewhat shorter in the middle through the presence of a posterior notch, which may become considerably deeper, dividing the disc into two very well marked halves when the large caudal hooks are in vigorous action, owing to the course of the muscular bands which are attached especially to the innermost forks of these. The suckers resemble in all respects those of Polystomum; the prominent rims do not present the rounded apertures which I have noticed above in P. oblongum. The diameter of the suckers is 0.27 mm. The large hooks (Fig. 13) differ in form from those of Polystomum or of any species of Dactylogyrus; and, in fact, except for the impair trabecula present in the latter genus, the hooks of some forms of Dactylogyrus and of Polystomum resemble each other more closely than they do those under consideration. The attached end of the hook is divided into two pieces: one—the longer—a thin, flat, somewhat linear splint in the continuation of the axis of the rounded body of the hook; the other, thicker, shorter and rounder, standing at an angle of 45° from that axis, with two prominences for muscular attachment. I observe that the splint-like portion is bent in some specimens; this is perhaps due to pressure in mounting. The free portion of the hook, just in front of the bend, bears two little curved teeth, one rising from the surface of the other, which probably assist in securing the attachment of the animal. Similar teeth seem to be present on the hooks of Dactylogyrus monenteron, Wagener.[27]

I have not been able to elucidate very successfully the structure of the smaller hooks. I have only attempted to indicate their position in Fig. 12. Even their number remains somewhat doubtful; only in one small specimen have I succeeded in making out sixteen. They are much less easy to observe in the larger worms; perhaps their functional importance diminishes with age, as I am inclined to believe of the corresponding structures in Polystomum. Especially those lying behind the large hooks seem to be important in the small

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[27] Beiträge z. Entwick. d. Eingeweidewürme, Pl. XIII., Fig. 8.

worms, as I find in two specimens the substance of the lamina projecting beyond the level of the rest with the base of the hook lodged in it.

Of the marginal hooks, most seem to have a trifurcate base, as represented in Fig. 14 (*b*); in others (*a* and *c*), there would seem to be a chitinous ring at the point of attachment similar to those noticed in the large hooks of Dactylogyrus by Wagener and V. Linstow.[28] The hooks situated in the centre of the suckers (*a*) appear to be slightly different from the others, additional chitinous rings of smaller size being present. The hooks measure about 0.025 mm. in length.

The mouth is situated in the middle of a somewhat funnel-shaped sucker upon the ventral surface of the head. From Dr. Osler's sketch I make out that the pharynx is situated shortly behind the mouth, and that the intestinal coeca diverge immediately from this to arch into each other (as in some forms of Monostomum) in the posterior fourth of the body.

The following is extracted from Dr. Osler's notes:

"The water-vascular system is well developed, beginning as a ramification of vessels about the anterior disc, and uniting to form two vessels, which run the whole length of the body, joining below, and opening somewhere between the posterior discs. Cilia are to be distinctly seen in the water-vascular system, especially at the junction of the tubes below. At the upper third of the body, on a level with the generative orifice, are seen on each side curious pulsating organs, which are undoubtedly connected with the water-vascular system, the pulsation occurring about once every minute and a half."

From the sketch accompanying this, these contractile bladders would seem to resemble in form, position and relative size, those represented in Epibdella Hippoglossi, by Van Beneden.[29]

The lobes of the vitellogen occupy the sides of the body, but do not extend into the caudal lamina, nor further forward than the generative aperture.

This is situated immediately behind the bifurcation of the intestine. I have only been able to determine its position from the cirrus-coronet in the mounted specimens. Dr. Osler, however, saw the female aperture quite close to this, leading into a "narrow, slightly-curved vagina." This I have represented in Fig. 13; it is probably the unexpanded uterus.

[28] V. Linstow, Trosch. Archiv., 1878. These seem also to be indicated in Zeller's figure, loc. cit., Taf. XVII., Fig. 3.

[29] Mémoire sur les Vers Intestinaux, Pl. II., Fig. 2.

The structure of the cirrus-coronet is difficult to ascertain on account of the semi-opacity of my mounted specimens. The pieces do not seem to be more than eight in number; they converge anteriorly where they are narrow and pointed; posteriorly they are wider, with somewhat arrow-head shaped ends, which fit into the terminal bulbous portion of the vas deferens. I have been unable to follow the rest of this tube, or to find any trace of the testes.

Sphyranura resembles P. oblongum and the precocious gill-cavity stage of P. integerrimum, in possessing only one complete shell-invested egg in the uterus at one time. This is very large (*v. supra*) in relation to the size of the worm, being considerably larger than the eggs of either P. integerrimum or P. oblongum. It consequently forms a noticeable feature in the worms possessing it, and is readily detectable with the naked eye. Numerous other eggs may be seen in the oviduct formed of the ovarian ova with the investing foodyolk-balls, and by mutual compression assuming various forms. What I suppose to be the ovary is represented in the figure to the right hand of the base of the muscular tube. I cannot find any trace of shell-gland, transverse vitello-duct, or of a vagina. All of these would undoubtedly be easily seen in fresh or well preserved specimens.

I regard the genera Gyrodactylus, Dactylogyrus, Sphyranura and Polystomum, as forming a very natural assemblage. All probably live on the blood of their hosts, being found in positions where there is a more or less close superficial vascular plexus; all possess a caudal disc armed with fourteen to sixteen small and two (rarely more) large hooks, which enable the fish-parasites to secure themselves firmly to the gill-filaments of their hosts. Those which possess suckers formed around the smaller hooks are found attached to smoother surfaces (mucous membrane of mouth and urinary bladder), where the small hooks alone would have little purchase; even these forms, however, pass through a suckerless stage in which they inhabit the anterior respiratory part of the intestinal tract.[30] The resemblance of the Polystomum-larva to Gyrodactylus is very striking, so that if any phylogenetic speculations may be made from the observation of the ontogeny of an animal, the assumption is surely justi-

[30] It must be remembered that the mucous membrane covering the hyoid arches of many Chelonia has still a high respiratory significance. *Vide* Agassiz: Contrib. Nat. Hist., U. S. Vol. I., Pt. ii., pp. 271–284.

fied that Polystomum is descended from a Gyrodactylus-like ancestral form. The suckers of Polystomum are not developed simultaneously, and Sphyranura is a transition form, where the formation of these is restricted to one pair.

The consideration of the probable relationships of the hosts of these forms lends additional authority to such a conclusion. If the piscine ancestors of Amphibia had Gyrodactylus-like gill-parasites, these would probably be transmitted to their descendants, and we should not be surprised that among the oldest representatives of these, two (the Frog-larva and Necturus) should possess such. The texture of the gills in Necturus might account for the change in the caudal armature. The loss of the gills in the Frog is necessarily accompanied by a change of habitaculum on the part of the parasite; and it is not surprising that the emigrating worms should have prospered so well in a locality where so many favourable conditions obtain as in the urinary bladder of the same host. That some Chelonia are the only reptiles in which parasites belonging to the same series have been found is probably to be accounted for by their aquatic habits.

Dactylogyrus may be regarded as a divergent form marked by its peculiar genital armature, the shape of the eggs, and the arrangement of the caudal hooks. In all of these points the three other genera approach each other more closely, and as Gyrodactylus is evidently nearer the stem-form than the others, all might be received into Van Beneden's family "Gyrodactylida."[31]

CESTODES.

TAENIA DISPAR. *Goeze.*

I have to record another habitaculum for this worm. The specimen of Rana halecina above referred to (p. 6), expelled several ripe proglottides which seem to be much smaller than usual, as will be seen from the measurements given below. In the intestine of the frog were found several chains about an inch and a half in length, and also many scolices and immature chains of different lengths. Many more worms in the two latter conditions were also found in the body cavity between the viscera; whether these become mature in this position I am unable to say—they certainly frequently occur here.

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[31] Recherches sur les Trematodes marins, Van Ben. and Hesse, p. 121.

The head does not measure more than 0.5 mm. across in any of my preserved specimens, nor in fact does any part of the chain. In life it is very variable in form, and bears a distinct unarmed rostellum, which is frequently completed retracted, so as to escape notice, but acts much like a fifth sucker. This is merely indicated in Van Beneden's figure,[32] and its existence is negatived in Diesing's and Dujardin's descriptions.

The only ripe proglottides observed were mostly of the form represented in Fig. 15, and measured 0.4 × 0.16 mm. Instead of containing a series of capsules in pairs with their contained embryos, two or three capsules at most were observed, with six or seven embryos altogether. These measured 0.027 × 0.018 mm.

NEMATODES.

ASCARIS ADUNCA. *Rud.*

A statement occurred in the "American Naturalist" in the course of last year, as to the prevalence of an Ascaris in the intestine of the American Shad—Alosa sapidissima, Storer. This was probably A. adunca, R. I have several specimens taken in last winter from Portland fish, which undoubtedly belong to this species.

The only other reference to a round worm from the American Shad of which I am aware is by Dr. Leidy, who records[33] Agamonema capsularia (?), Diesing, as free in the intestines. This, in spite of the "undivided lip," is probably the young of A. adunca, the "obtusely conical, minutely mucronate tail," arguing for this. Molin[34] describes "Nematoideum Alausæ" also with mucronate tail, but with a four-papillate mouth from the European Shad, but considers that the absence of lips forbids its reference to A. adunca. The metamorphoses of the mouth-parts in Ascaris are still insufficiently known, but what has been already established[35] does not exclude the possibility of both of the above larval forms belonging to A. adunca.

FILARIA TRIAENUCHA, *n. sp.*

A single female specimen of a worm belonging to the genus Filaria was found in the upper part of the proventriculus of each of the

[32] Mém. sur les Vers Intest., Pl. XXII., Fig. 4.
[33] Proc. Ac. Sci. Phil., VIII., p. 55.
[34] Sitz. d. k. Akad. Wien., XXXVIII., p. 31.
[35] Schneider Monog. der Nemat., p. 294.

Bitterns above referred to, along with a single male of Ascaris microcephala, Rud. (?) in one of these; and although closely related to two species (F. laticeps, R., and F. tridentata, V. Linstow[36]) which have been described from Falco lagopus on the one hand, and from Colymbus arcticus and Larus ridibundus on the other, it does not appear to resemble any of the numerous Filariæ described from Ciconiæ, except perhaps F. alata.

I hope I may shortly have an opportunity of examining the disposition of the præ- and post- anal papillæ in the male, a character of essential systematic value in this genus; in the meantime, however, I record the following points which seem to distinguish it from the above mentioned forms:

> Densely striated. Length 10 mm.; greatest breadth, 0.43 mm. A cervical fascia or frill, the tops of the lateral loops of which are 0.18 mm. from the anterior end, and which extends 0.405 mm. backwards on the neck. The root of the cervical papilla (or trifurcate spine) is 0.06 mm. from the end of the frill. The trident measures from the root to the end of the median fork 0.06 mm. The eggs measure 0.027 mm. × 0.018 mm. The tail is terminated by a short rounded conical projection.

A comparison of Fig. 16 with the figures of Schneider[37] and V. Linstow, will show how it differs from the similar structures represented there, the teeth of the trident being much longer and narrower in proportion to the body. The uterus was packed full of eggs, so that its walls were extended in every direction, occupying almost the whole of the body cavity.

ANCYRACANTHUS CYSTIDICOLA (Schn.) *R.*

I find this worm very commonly present in considerable numbers in the swim-bladder of Salmo siscowet, Ag. The males are, however, usually about twice (19–22 mm.) the length recorded by Schneider, while the females measure 30–33 mm. The two teeth (Fig. 17) which are doubtfully ascribed to the head by Schneider are quite evident in my specimens, and are continuous with two longitudinal ridges in the œsophagus. It is somewhat difficult, on account of the coiled up tail, to get a satisfactory view of the papillæ in the male, but there seemed to be five pairs of these behind the anus. The eggs measure 0.04 × 0.02 mm.

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[36] Trosch. Archiv., 1877, pp. 10 and 175.
[37] Loc. cit., Taf. VI., Fig. 3.

ANCYRACANTHUS SERRATUS, *n. sp.*

A single female specimen of a worm closely allied to the above was obtained from the auricle of the heart of Coregonus albus, Le S. It only measures 11 mm., and differs from A. cystidicola in the mouth-armature. Instead of having only the two teeth of that species, there are a series of smaller ones disposed, as represented in Fig. 18, round the anterior end. The eggs in this specimen were not mature, but the genital organs were observed to be arranged as in the above species. The structure of the œsophagus is sufficient to place the worm in this genus, and I propose provisionally for it the specific name "serratus."

TORONTO, December, 1878.

EXPLANATION OF THE FIGURES.

PLATE I.

FIG. 1.—Distomum heterostomum, Rud. (?); *vi*, vitellogen; *sch*, "schluckœffnung;" *t*, testes.

FIG. 2.—End of an intestinal coecum of the same.

FIG. 3.—D. asperum, *n. sp.*; *ga*, genital aperture; *vo*, the ovary; *tv*, transverse vitello-duct.

FIG. 4.—Head of same; the characteristic disposition of the hooks is best represented on the right side.

FIG. 5—An isolated body-spine of the same.

FIG. 6.—D. reticulatum, *n. sp.*; the ventral sucker (*vs*) is flattened; *u*, the uterus; *lv*, the ventral; *lvd*, the dorsal longitudinal vitelloduct; *tt*, the testicular tubes.

FIG. 7.—Surface view of intestinal epithelium of D. variegatum, Rud.

FIG. 8.—Caudal sucker of Octobothrium sagittatum, F. S. Leuck. (?).

FIG. 9.—Polystomum oblongum, *n. sp.*; *l*, larva; *ck*, cirrus-coronet; *va*, vaginae; *ov*, shell-gland (?).

FIG. 10.—Large caudal hook of the same.

FIG. 11.—Small caudal hook of the same.

FIG. 12.—Sphyranura Osleri, *n. sp.*; *ov*, eggs.

FIG. 13.—Large caudal hook of same.

FIG. 14.—Small caudal hook of same.

FIG. 15.—Proglottis of Taenia dispar, Goeze.

FIG. 16.—Cervical papilla of Filaria triaenucha, *n. sp.*

FIG. 17.—Head of Ancyracanthus cystidicola, Schn.

FIG. 18.—Head of A. serratus, *n. sp.*

PLATE II.

FIG. 19.—Octobothrium sagittatum, F. S. Leuck. (?); *ga*, genital aperture; *o*, a mature ovum; *ov*, the ovary; *vd*, vas deferens.

FIG. 20.—Anterior end of same to show shape of mouth, anterior suckers and pharynx.

FIG. 21.—Genital sucker of same; *a*, superficial; *b*, deeper view.

FIG. 22.—Mature ovum.

SYLVA CRITICA
CANADENSIUM.

1—6,

BY THE REV. JOHN McCAUL, LL.D.,
President of University College, Toronto.

1. In Cicero, *Phil.* II., c. xxxi., are the following words, of which I have never seen any interpretation that I believe to be correct:

"O hominem nequam! quid enim aliud dicam? magis proprie nihil possum dicere."

The ordinary acceptation of *nihil possum dicere* is, "I can give no name *magis proprie* than *nequam*." I am inclined to think that it should be—"I can call thee *magis proprie* 'thou nothing.'" Cicero, when he said *nequam*, had not reached the limit of revilement, for he might have said *nequissimum*. I would translate the whole passage thus: "O good for nothing man! for what else am I to call thee? Yes! I can give thee a name more peculiarly thy own—'thou nothing.'" It is remarkable that we have in Horace (*Sat.* II., vii., 100) these words—*nequam* and *nil*—in juxtaposition, in a similar sense:

> Nequam *et cessator Davus; at ipse*
> *Subtilis veterum judex et callidus audis:*
> Nil *ego, si ducor libo fumante.*

We find other examples of this use of the word *nil* (or the equivalent *nihil*) in Cicero—*e. gr.*, *Epist. Famil.* vii. 27, *te* nihil *esse cognosceres*, and in *Divin. Verr.* 14, nihil *fueris* and 15, nihil *est*, *nihil potest*. Similarly *οὐδὲν* is used in Greek, *e. gr.*, Eurip., *Orest.* 718) *ὦ πλὴν γυναικὸς οὕνεκα στρατηλατεῖν Τἆλλ' οὐδὲν, κ. τ. λ.*

2. In the *Ephemeris Epigraphica*, 1877, Vol. III., pp. 113–155, are the *Additamenta* by Prof. Hübner to the Inscriptions of Britain as given by him in the 7th volume of the "*Corpus Inscriptionum Latinarum.*" They have been chiefly supplied by Mr. W. Thompson Watkin. Among the remarks given there is the following: "Ad n. 906. In C. A. latere custodem armorum Buechelerus coniecit probabiliter. Titulus igitur ita legendus videtur esse: *d*(*is*) *M*(*anibus*,

Gemelli c(ustodis) a(rmorum) Fl(avius) Hilario s(ecundus) h(eres) f(aciendum) c(uravit).

The stone is figured in *Lapidarium Septentrionale*, n. 446. It is expanded thus, and the following remarks are given:

"DM	Diis Manibus
GEMELLI · C · A ·	Gemelli carissimo amico (?)
FL · HILARIO · S · H · FC ·	Flavius Hilario secundus heres faciendum curavit.

"This inscription has been variously expanded. For the reading here given the editor is indebted to Professor Henzen, who in a private communication says: 'Second heirs occur very frequently in military inscriptions; and though our inscription does not belong to a soldier, it must have belonged to a person attached to the camp. Therefore I have little doubt about my explanation.' The only remaining difficulty belonging to the inscription is the expansion of C. A. at the end of the second line. Professor Hübner thinks that the letters 'indicate a military charge.' Dr. McCaul proposes to read the line '*Gemelli custodis armorum.*'"

In the *Canadian Journal*, Vol. XII., p. 122 (to which the learned editor of the *Lapidarium Septentrionale* refers), the following are the terms of the article on this inscription, in the Review of Dr. Bruce's Roman Wall, 3rd Edition:

'In consequence of the incorrect representations of the inscription that have hitherto been given, the last two letters of the word *Gemellica* being separated from the rest, and a full stop after each, great has been the perplexity of those who have attempted to read it, and various the interpretations that have been given of it. Gemellica, it must be confessed, is a name which we have not previously met with. *Diis Manibus. Gemellica Flavio Hilario sepulchrum hoc fieri curavit.* To the divine manes. Gemellica to Flavius Hilarius caused this sepulchre to be erected.'

"If the reading *Gemellica* be assumed as correct, I would read the inscription thus: '*Diis Manibus. Gemellica. Flavius Hilario secundus heres faciendum curavit.*' *Gemellica* may be in the nominative, or may stand for *Gemellicæ*. *Hilario* is a name that occurs more frequently than *Hilarius*, and *secundus heres* is not uncommon. See Orelli, nn. 3416, 3481. The head, however, which is carved below the inscription seems to be rather that of a man with a beard, than of a woman with a head-dress. Hence I would suggest, instead of *Gemellica*, GEMELLI · C · A., *i.e.*, *Gemelli custodis armorum;* and this I regard as the most probable rendering."

It appears, then, that the interpretation of C. A. was originally given in the *Canadian Journal* in 1868.

3. The remark immediately following this in the *Ephemeris Epigraphica*, 1877, is: "Ad n. 914. V. 6 ad Solvam Norici oppidum rettulit Buechelerus in censura, recte puto. Itaque solvendum *Mar(ti) Coc(idio) m(ilites) leg(ionis)* II *Aug(ustæ) c(enturia) Sanctiana c(enturia) Secundini d(omo) Sol(venses)* e. q. s.

The stone is figured in the *Lapidarium Septentrionale*. It is expanded thus, and the following remarks are given:

"MARTI COC M
LEG · II AVG
> SANCTIANA
> SECVNDINI
D · SOL · SVB CV
RA · ÆLIANI C (?)
CVRA · OPPIVS
FELIX OPTIO
Marti Cocidio milites
legionis secundæ Augustæ
Centuria Sanctiana
centuria Secundini
Deo (?) Solverunt (?) sub cu
ra Æliani centurionis (?)
curavit Oppius
Felix optio

"The inscription presents some difficulties. The meaning seems to be this—the altar was dedicated to Mars Cocidius; the dedicators were some soldiers belonging to two centuries of the second legion, the century Sanctiana, and the century of Secundinus; the party being at the time under the command of the centurion Ælianus; Oppius Felix, the *optio*, took charge of its erection.

"The editor has in vain sought for some authority for the expansion of the letters D · SOL · in the fifth line. None is to be found. The Rev. John Hodgson reads *de solo;* such an expression is often used as to a building, but is inapplicable to an altar. Professor Hübner suggests, though very doubtfully, *dato solo*. Mr. Clayton proposes *deo* or *deis solverunt*."

The letters D · SOL, doubtless, present very considerable difficulty. I have never met with them before. Various expansions have suggested themselves to my mind, the best of which I regard the following:—D[evoti] SOL[i]. With this view we may compare the inscription in Lersch, *C. Museum*, n. 14, Bonn, or Steiner, *Cod. Inscrip. Rom. Danubii et Rheni*, n. 1268:

IN · H · D · D · PRO
SALVTE · IMP · SEVERI
ALEXANDIRI · AVG · DEO
APOLLINI · DYS · PRO · LV · S
OLQ · DE · MILITES · LEG ·
XXX · V · V · P · F · SVB · CVRA
AGENT · T · F · APRI
COMMODIAN · e · q · s ·

i. e., In honorem domus Divinæ, pro salute Imperatoris Severi Alexandri Augusti, Deo Apollini, Dis propitiis Lunæ Solique devoti milites

legionis tricesimæ Ulpiæ Victricis, sub cura agentium Titi Flavi Apri Commodiani.

4. In the *Ephemeris Epigraphica*, 1877, Vol. III., pp. 132, 133, the following account is given of two inscriptions, on which I offered some observations in the *Canadian Journal*, Vol. XIV., p. 544:

"Legendum igitur Victoriæ Augg. Alfeno Senecion[e] co(n) s(ulari) felix ala [prima] As(turum). *Senecioni* pro casu sexto fortasse positum est barbare. Manifestum est, alam ipsam felicem dictam lapidem dedicavisse (ut infra in n. 100 hujus additamenti); sed quid M et PRA litteræ significent, quæ iam non possunt coniungi cum reliquis, ignoro; nisi fuit M(arciano) pra(efecto). Expectamus cognomina alæ imperatoria, veluti *Antoninianæ*. Ceterum in altero textus exemplo omnino desunt. Observa Genios, non Victorias, in lateribus. Hæc mecum communicavit W. Th. Watkin.

In the *Journal of the Archæological Institute*, 1878, Vol. XXXIV., p. 144, Mr. W. Thomson Watkin writes thus, having given an account of the copy of the inscription in the Ashmolean Museum:

"In any case the correct reading of the stone is established, showing that the word *Felix*, instead of being a proper name, is used in the same sense as in the inscription lately found at *Cilurnum*."

The inscription lately found at Cilurnum is thus given by Hübner, in n. 160 of the *Additamenta*:

(S)ALVIS AVGG
(F)ELIX · ALA · $\overline{\text{II}}$ · ASTVR
A
VIRTVS
AVGG ·

Bruce lapid. append., p. 472, n. 943, qui annotat alteram G in vocabulo AVGG utroque loco eradi cœptam esse. Idem accidit vocabulo [Antoninian]a. Brucius non sine probabilitate propter titulum, n. 585, in quo Antoninianæ cognomen item erasum est, cogitavit de Elagabalo et Alexandro Augustis. Alam II. Asturum Cilurni in castris fuisse ad quintum usque sæculum notum est.

The stone is figured in the *Lapidarium Septentrionale*, n. 943, and the following expansions and remarks are there given:

"Salvis Augustis
felix ala secunda Asturum
Antoniniana (?)
Virtus
Augustorum."

"The inscription is different from any that we have previously met with. The evident meaning of it is, 'So long as the Emperors are safe the second ala of Asturians will be happy.' A reference to the inscription, n. 121, leads us to suppose that the Emperors to whom this flattering compliment was paid were Elagabalus and Severus Alexander. Very soon after this inscription was carved

Elagabalus was slain by the infuriated soldiery at Rome, and the second ala of Asturians, at Cilurnum, sympathizing with them, erased, though not entirely, the second G at the end of the first line, and that at the end of the inscription (VIRTVS AVGG) in the hands of the standard-bearer, as well as the whole of the third line of the principal inscription, which was probably an epithet which the ala had been permitted to assume, by favour of the unfortunate Emperor when he was a popular idol."

I now subjoin the remarks which appeared in the *Journal* in 1873:

"The inscription, given by Orelli,* n. 864, confirms Dr. Bruce's view of the meaning:—ΣΑΛΒΩ ΚΩΜΜΟΔΩ ΦΗΛΙΞ ΦΑΥΣΤΕΙΝΑ, *i. e.*, *Salvo Commodo felix Faustina*, but his reference of AVGG to Elagabalus and Severus Alexander is certainly incorrect. So far as we are aware, there is no example of the application of the term *Augusti* to those two Emperors. Nor is there any evidence that they were united under that name. To us it seems highly probable that the two Augusti were Caracalla and Geta, that the date is A.D. 211, after the death of Severus, and that the second G was erased after the murder of Geta, in A.D. 212. But the most interesting result of this discovery is, that the inscription throws light on another which unfortunately is lost. It is given from Horsley, in the *Lapidarium Septentrionale*, n. 27, and in *Britanno-Roman Inscriptions*, p. 133:

"VICTORIAE
* * GGALFE
N S SENECIO
N COS FELIX
ALA I ASTO
[RV]M PRA

"Of the true reading of the main part of the inscription there can be but little doubt. It is—*Victoriæ Augustorum Alfenus Senecio Vir Clarissimus Consularis Felix Ala prima Astorum.* ALA has been regarded as standing for ALAE, the letters RVM as the final three of *Astorum* for *Asturum*, and PRA as the first three of *Præfectus*. Thus *Felix* was regarded as Præfect of the first Ala of Asturians. With others we have accepted this view, but it has always appeared strange to us that *Felix* had neither *prænomen* nor *nomen*. Now it seems most probable that *Felix* is used as it is in n. 943, and Baxter's reading, ALFENO SENECIONE, is not so unlikely. What the letters at the side were that were crowded out can scarcely be conjectured with probability; they may have been something like *Curam Agente*, or *Curante Præfecto*." †

I believe the AVGG of the two inscriptions to be the same—*Severus* and *Caracalla* (or *Caracalla* and *Geta*)—and that the date of these inscriptions was A.D. 209—before Geta was declared Augustus, on the news reaching the army in Britain, that although the expedition into

* See also Eckhel, viii. 11.

† There is a strange mistake relative to this Præfect in Dr. Bruce's General Index to the *Lapidarium Septentrionale*: "Alfenius Senicio, Prefect of the Ala Prima Asturum, 81; his titles on other inscriptions, 81."

Caledonia was attended with great difficulties, yet the Emperors were safe—or A.D. 211.

5. In the *Ephemeris Epigraphica*, 1877, Vol. III., pp. 161–163 and 203, 204, there are *Additamenta* to Prof. Mommsen's article on *Tesseræ Gladiatoriæ*, in Vol. I. of the *Corpus Inscriptionum Latinarum*. From these it appears that there are now* known to exist six examples of the word *spectavit* in full, viz.:

(1) DIOCLES
VECILI
SPECTAVIT
A · D · V · K · FEBR.

(2) PHILOMVSVS PERELI
SPECTAVIT

(3) PROTEMVS FALERI
SPECTAVIT
N · S.

(4) GENTI · PACONI · T · S.
SPECTAVIT

(5) MENOPIL · ABI · L · S ·
SPECTAVIT
C · VAL · M · HER.

(6) PAMPHIL · SOCIORW
SPECTAVIT

i.e., (1) *Diocles, Vecili* (*servus*), *spectavit*, *a*(*nte*) *d*(*iem*) *q*(*uintum*) *K*(*alendas*) *F*(*ebruarias*). (2) *Philomusus Pereli* (*servus*), *spectavit.* (3) *Protemus Faleri* (*servus*), *spectavit*, *N*(*onis*) *S*(*extilibus*) *or S*(*eptembribus*). (4) *Genti*(*us*) *Paconi T*(iti) *S*(ervus), *spectavit.* (5) *Menopil*(us) *Abi L*(ucii) *S*(ervus) *spectavit C*(aio) *Val*(erio) *M*(arco) *Her*(ennio) (*Consulibus*) *i.e.*, A.V.C. 661 = 92 B.C. (6) *Pamphil*(*us*) *Sociorum* (*servus*) *spectavit.* In 1863, the most ancient then known was of the date 85 B.C. The only real difficulty is in SP, which has been expanded by *spectatus*, *spectator* or *spectavit*, to which we should now, perhaps, add *spectat*, or we may regard *spectat* as an abbreviation of *spectator*—*spectator* [*fuit*] being believed to be = *spectavit.* In the volume of the *Canadian Journal* for that year, there is an article by me on the subject. From that article I subjoin extracts, as I cannot but regard the suggestion given there as more probable than any other explanation that I have seen, even including that offered by Prof. Mommsen, and stated at the close of the article in the *Ephemeris Epigraphica*, Vol. III., p. 163:

"In mentem venit Momseno (mihique visum est probari posse) gladiatores rude donatos fortasse transiisse ex arena in carcerem, spectandique ius adeptos esse ibi, ubi antea spectabantur. Eius iuris initium memoriæ tradi potuit veluti honesta missio quædam in tesseris gladiatoriis. Horatii versus sane non obstat huic opinioni."

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* In 1863 there were only two (doubtful) specimens of *tesseræ* giving the word *spectavit.*

The extracts from my article are:

"The sense in which this expansion (*spectatus*) was generally* understood, was, that the gladiator to whom the *tessera* was given was 'tried,' 'approved,' and allowed to retire on the specified day of the month in the year indicated by the specified consuls. In support of this interpretation the well-known verses were cited:

'Spectatum *satis, et donatum jam rude quæris*
Mæcenas, iterum antiquo me includere ludo.'

Morcelli, *De Stilo*, i. p. 412, suggested, instead of *spectatus*, *spectavit*, † on the authority of an inscription given by Tomasini and Fabretti, in which that word appeared on a *tessera, in extenso, scil.* PILOMVSVS · PERELI · SPECTAVIT. The sense in which he understood the word, was, 'was a spectator,' 'took his seat amongst the citizens and looked on.' He believed that these *tesseræ* were given to gladiators who had received not only the *rudis*, but liberty, and that they entitled those who had received them to sit amongst the citizens. The inscriptions would thus be regarded as stating the date of the first occasion on which such gladiators availed themselves of the privilege conferred by the presentation of the *tesseræ*. Another expansion, *spectaculum*, has been proposed by Gori, *Inscrip.* i. 74, but I am unable to conjecture in what sense ‡ he understood it. Morcelli, who notices this expansion, dismisses the reading with the expressive phrase—*quod miror*. . . . We may now assume that the first two syllables of the word are SPECTAT, on the authority of the following inscription, on an unquestionably genuine *tessera*, published for the first time by Mommsen, ‖ p. 201:

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* Thus Reinesius, *Syntag.* p. 372, remarks: "*Fulvius Ursinus putabat significari videri, quo anno seu consulatu, mense ac die gladiator spectatus, diu multumque in arte versatus, rude sit ac tessera eburnea donatus, quibus solutum se palæstræ atque arenæ legibus athletam ostenderet.*" Amati, *Giornale Arcad.* 1826, explains *spectatus* thus: "*Le picciole taglie quadrilatere di avorio or di osso erano visibili documenti di morte pe ressi gladiatori ad altri recata, e almeno di sanguinosa vittoria ottenuta con atterrar l'avversario.*" Tomasini, *De tesseris*, makes the astonishing statement: "*Erat autem rudis tessera quædam eburnea, cui nomen gladiatoris ætate emeriti inscribebatur quam qui accipiebat, is ab omni pugnandi necessitate eximebatur.*" It is scarcely necessary to remark relative to this view, that there is no authority for the notion that the *rudis* was a *tessera*.

† Ursatus, *De Notis Romanorum*, remarks: "SP. Spectatus, *Pignorius, qui*, De Servis, *scribit, hanc notam quæ doctos viros hucusque torsit, nihil aliud 'Significare, quam, spectavit, ut detur intelligere, conductos fuisse aliquos, veluti ab editore, gladiatores insignes, rude olim donatos, spectandi gratia, non pugnandi.*'" Pitiscus, *Lexicon*, in *tessera*, Facciolati, *Lexicon*, in *Specto*, and Orelli, n. 2561, adopt the view of Morcelli. Henzen, n. 6162, seems to pre er *spectatus*. Zell, *Delectus*, p. 60, reads *spectandus*.

‡ Muratori, *Nov. Thes.* p. DCXI. n. 2, explains SP. as meaning that the person named informed the people that he had given or intended giving a *spectaculum*.

‖ The account of this is so interesting that I give the words: "*Sero reperi in libro ms. Lanthelmi Romieu Arelatensis scripto a.* 1574, *servatoque hodie Lugduni Bat. inter Voss Germ. Gall. Q.* 1. *Legitur ibi f.* 88 *sic:* Ores ie commence icy à fere mention des Epitaphes d'Arles —— —— et en premier lieu ie veux reciter l'escrit memorable, qui se list clairement en une piece d'ivoire ou plustot de corne de cerf, que i'ay, qui a esté nouvellement trouvée icy a la poincte au bord du Rosne, la quelle est si menue et estroicte, qu'elle n' est pas plus longue, ne plus large, que la moytie du petit doigt de ma main, etant percée à l'un des bouts: ou est faite mention de Ciceron, et de Caius Antonius."

MENSE · FEBR · M · TVL · C · ANT · COS · ANCHIAL · SIRTI · L · S · SPECTAT · NVM.

From this it appears that of the two expansions *spectatus* is the more probable; but even it is not satisfactory, and Mommsen with good reason calls it in question. He objects that the words of Horace by no means prove that *spectatus* was the proper or ordinary term for expressing the fact that a gladiator had fought.* *Pugnavit*, he believes, would be much more clear and suitable than *spectatus est*. He also notices the inconsistency of the days named on the *tesseræ* with the days which we know were fixed for the *ludi gladiatorii* at Rome, viz., a. d. xiii. xii. xi. x. k. Apr. To these objections I would add, that there is no notice, so far as I am aware, in any ancient author, of *tesseræ gladiatoriæ*.† The designation is a modern invention, accepted and used by those archæologists who read SP as *spectatus*, with reference to gladiators. . . . When I first examined the inscriptions on the *tesseræ consulares*, I had seen only those containing the names of slaves, and was inclined to conjecture that they might have been given to persons of that class as testimonials of approved character. Thus Terence, *Adelphi*, v. 6, 5, *is mihi profecto est servos* spectatus *satis*. On re-examination of the subject two or three years ago, I found the names of freemen also; and observing the frequent mention of the Calends, Nones and Ides, I was led to think that the *tesseræ* were in some way connected with money. Hence I conjectured that the word was SPECTATOR, in the sense "examiner of money;" and now, perceiving that this conjecture derives support from SPECTAT · NVM · (*i. e.*, as I read it, *spectator numorum* or *numularius*) ‡ in the recently published Arles inscription, I submit this reading as more probable than any of which I am aware.

"Of the use of *specto* and its derivatives in this sense, the following passage affords sufficient evidence: *Ex omni pecunia certis nominibus deductiones fieri solebant, primum pro* spectatione, &c. Cicero, *Verr.* v. 78; *Cape hoc, sis. Quin das? Numi sexcenti heic erunt Probi, numerati; fac sit mulier libera, Atque huc continuo adduce. Jam faxo heic erit. Non, hercle, quoi nunc hoc dem* spectandum, *scio.* Plautus, *Persæ*, iii. 3; *Quum me ipsum noris, quam elegans*

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* The sense in which the word was understood by the greater number of those who received it, conveyed more than this, as I have elsewhere stated. Mommsen's objection, however, as to the application of *spectatus* to gladiators is valid in whatever sense the term was taken. Indeed I do not recollect any passage in a Latin author, besides that cited from Horace, in which *spectatus* is used with a reference, direct or indirect, to gladiators.

† This designation is used by Maffei, Fabretti, Orsato, Marini, &c. And yet the phrase is, as I have remarked, unsanctioned by ancient authority. There is no passage with which I am acquainted that mentions any such object as a *tessera* given as a reward, unless the words *tabulam illico misit* in Suetonius, *Claudius*, c. 21, be taken in this sense, as Morcelli interprets them. His explanation, however, is, in my judgment, very unsatisfactory. He seems to have forgotten the statement in Dio Cassius, lx. 13, relative to the usage of Claudius at these shows: κήρυξι μὲν ἐλάχιστα ἐχρῆτο, τὰ δὲ δή πλείω ἐς σανίδας γράφων διεδήλου; *i. e.*, *Præconibus rarissime usus est ac pleraque* tabulis inscripta *significavit.*

‡ The *numularii* did more than tell whether coin was good or base. They seem to have been like our money brokers. Their occupation and position were below those of *argentarii*. In the Theodosian Code, xvi. 4, 5, *servi* and *numularii* are classed together.

formarum spectator *siem*. Terence, *Eunuch*, iii. 6, on which Donatus remarks: '*Spectator, probator, ut pecuniæ* spectatores *dicuntur*;' *Adcipe: heic sunt quinque argenti lectæ numeratæ minæ.* Plautus, *Pseudol*, iv. 7, 50; *Lectum'st: conveniet numerus quantum debui.* Terence, *Phormio*, i. 2, 3, on which Donatus remarks: 'Spectatione *lectum est*;' *Veri speciem calles, ne qua subærato mendosum tinniat auro?* Persius, v. 105, on which Kœnig remarks: '*Sumptum hoc ab illo hominum genere, quorum erat* probare numos, *quique* spectatores *vel docimastæ vocabantur*.' In later times, the provers of gold were called *spectatores*, as we know from Symmachus, *Epist.* iv. 56: *Nullo jam provincialis auri incremento trutinam* Spectator *inclinat.* In none of our English works on archæology is there any explanation of either of these terms—*spectatio* or *spectator*—but the necessity for employing persons skilled in distinguishing base from good coin, and the origin of this *spectatio*, are well pointed out in an article by Dr. Schmitz, on *Moneta*, in Smith's 'Dictionary of Greek and Roman Antiquities:'

"'As long as the Republic herself used pure silver and gold, bad money does not seem to have been coined by any one; but when, in 90 B.C., the tribune Livius Drusus suggested the expediency of mixing the silver which was to be coined with one-eighth of copper, a temptation to forgery was given to the people, and it appears henceforth to have occurred frequently. As early as the year 86 B.C. forgery of money was carried on to such an extent that no one was sure whether the money he possessed was genuine or false, and the prætor M. Marius Gratidianus saw the necessity of interfering. (Cic. *De Off.* iii. 20.) He is said to have discovered a means of testing money and of distinguishing the good from the bad denarii. (Plin. H. N. xxxiii. 46.) In what this means consisted is not clear; but some method of examining silver coins must have been known to the Romans long before this time. (Liv. xxxii. 2).'

"Dr. Schmitz's interpretation of the passage in Pliny's Natural History seems to me very doubtful. The words are—'*Miscuit denario triumvir Antonius ferrum. Miscentur æra falsæ monetæ. Alii e pondere subtrahunt, quum sit justum lxxxiv e libris signari. Igitur ars facta denarios probare, tam jucunda lege plebi, ut Mario Gratidiano vicatim totas statuas dicaverit.*' *Ars facta denarios probare* do not appear to me to signify 'a means of testing money and of distinguishing the good from the bad denarii was discovered,' for that cannot have been done *lege*, 'by a law;' but rather 'the testing of denarii was made an art, became a recognized occupation,' *i. e.*, the law of Gratidianus provided for the appointment or recognition of a certain class, whose business it was to distinguish good and base denarii. . . . . .

"It seems not improbable, then, that these *tesseræ* were carried, or, it may be, hung round the neck, by those who acted as *spectatores*, as badges indicative of their occupation, and that the inscription showed that they were authorized to act as such, having been approved on the stated days, or in the stated months. Thus the frequency of the occurrence of the Calends, Nones and Ides seems to be satisfactorily accounted for; for these were, as is well known, the settling days, the principal times for money transactions. But a question presents itself—which may also be asked if we accept the old reading *spectatus* with reference to gladiators—why the days are stated on those *tesseræ* which were found at or near the city, whilst the three examples of the month alone are on those found in other places, viz., Parma, Modena and Arles? Mommsen is of opinion that perhaps we should take in these instances the month as used for the Calends of the month—'*fortasse intelligendæ sunt ipsæ kalendæ in tesseris his nescio quo-*

modo præcipuæ.' Another explanation of this distinction may be given by supposing that these badges or certificates were issued in Rome on any day of the month on which they were applied for, especially the Calends, Nones and Ides, being those on which the services of the *spectatores* would be most required; whilst in the country parts they were issued only once in the month, the day for such issue not being fixed, but left to the discretion of the issuing officers.

"Still another view may be taken, that these *tesseræ* indicated the time, not from which the persons holding them might act as *spectatores*, but for or during which they were empowered to discharge that duty—in the city for a specified day—in the country for a specified month."

6. About a year ago I was asked to explain an inscription that was stated to have been found on a stone in Syria. It was "ANN · XII · P · C." I suggested that there was a letter left out between P · C., and that the letter was *V.*, *i.e.*, I read the inscription "*Ann(o) Duodecimo post urbem conditam*," and gave as instances Gruter, 113, 2, and Orelli, 3694, 3697. It appears, however, that the reading, *Anno duodecimo post Christum*, was preferred. In this article I propose examining the subject, so that there may be no reason for doubt. If the reading which was preferred be correct, I am compelled to infer that the inscription was spurious, for the era—A.D., *anno Domini*, P.C., *post Christum*, or A.C., *ante Christum*—was introduced by the monk, *Dionysius Exiguus*, in the sixth century after the birth of our Lord—some say in 525, others in 527, and others again in 532. Dionysius placed the Nativity in A.V.C. 753, and recommended the substitution of this mode of computation for the others that were then used, specially for the era of Diocletian. The following extract from "Hales' Chronology" may be useful:

"Unfortunately for ancient chronology, there was no one fixed or universally established era. Different countries reckoned by different eras, whose number is embarrassing, and their commencements not always easily to be adjusted or reconciled to each other; and it was not until A.D. 532 that the Christian Era was invented by *Dionysius Exiguus*, a Scythian by birth, and a Roman abbot, who flourished in the reign of Justinian.

"The motive which led him to introduce it, and the time of its introduction, are best explained by himself, in a letter to Petronius, a bishop:

"'Because St. Cyril began the first year of his cycle [of 95 years] from the 153rd of Diocletian, and ended the last in the 247th; we, beginning from the next year, the 248th, of that same tyrant, rather than prince, were unwilling to connect with our cycles the memory of an impious [prince] and persecutor; but chose rather to antedate the times of the years, from the incarnation of our Lord Jesus Christ, to the end that the commencement of our hope might be better known to us, and that the cause of man's restoration, namely, our Redeemer's passion, might appear with clearer evidence.'

"The era of Diocletian, which was chiefly used at that time, began with his reign, A.D. 284; and therefore the new era of the incarnation, A.D. 284+248 =A.D. 532. Strauchius, and other chronologers, I know not upon what grounds, date it A.D. 527, five years earlier.

"How justly Dionysius abhorred Diocletian's memory, may appear from Eusebius, who relates, that in the first year of his reign, when Diodorus the bishop was celebrating the holy communion with many other Christians in a cave, they were all immured in the earth, and buried alive! Hence, his era was otherwise called the Era of the Martyrs; and not from the tenth, last and bloodiest of the Christian persecutions by the Roman emperors, in the 19th year of his reign.

"Dionysius began his era with the year of our Lord's incarnation and nativity, in U.C. 753, of the Varronian Computation, or the 45th of the Julian Era. And at an earlier period, Panodorus, an Egyptian monk, who flourished under the Emperor Arcadius, A.D. 395, had dated the incarnation in the same year.

"But by some mistake, or misconception of his meaning, Bede, who lived in the next century after Dionysius, adopted his year of the Nativity, U.C. 753, yet began the Vulgar Era, which he first introduced, the year after, and made it commence Jan. 1, U.C. 754, which was an alteration for the worse, as making the Christian Era recede a year further from the true year of the Nativity."

As the foregoing extract sufficiently explains the motive that influenced Dionysius, and the manner in which he introduced the new mode of computation, it remains for me to discuss the date of the Nativity, so as to indicate the errors of the date of the Vulgar Christian Era.

The date of our Lord's birth includes the year, the month, and the day. We shall first consider the year, and then proceed to the month and the day. First, it is evident that our Lord's birth-day must have preceded the death of Herod, for we are told by St. Matthew that the return from Egypt took place "when Herod was dead." If, then, we can find out the year of Herod's death, we may be sure that, as "Jesus was born in the days of Herod the King," the year of the birth of Jesus Christ must have been before that. From Josephus, *Antiq.* xvii. 8, § 1, it appears that Herod died, having reigned thirty-four years from the murder of Antigonus, and thirty-seven years from the date of his appointment as king. The latter event (on the same authority, *Antiq.* xiv. 14, § 5,) was in the consulship of *Domitius Calvinus* and *Asinius Pollio.* Now we know that they were consuls in A.U.C. 714. But we also know (Josephus, *Antiq.* xiv. 16, § 4,) that the death of Antigonus took place in the consulship of *Vipsanius Agrippa* and *Caninius Gallus*, *i.e.*, in A.U.C. 717; and further, there is evidence that proves that in the

calculations of time by Josephus, he counts from the Jewish month, *Nisan* to *Nisan*, and that he reckons the portion of a year, either at the beginning or at the end, as one complete year. Hence it follows that the birth of Christ preceded the date of 754 A.U.C., which is the Vulgar Christian Era, by at least four years, for the death of Herod should be placed in 750 A.U.C. But we can ascertain not merely the year but the month of Herod's death, for it was between an eclipse of the Moon (March 13th), and (Josephus, *Antiq.* xvii. 6, 4,) shortly before the feast of the Passover, so that it was in the month of March. The year of our Lord's birth must then have preceded March, B.C. 4. But from St. Matthew ii. 16, it appears that the year of the birth of our Lord should be placed about two years or under before the death of Herod, or, if we accept the inclusive method of counting years, between one year and five or six months before that event. This will give us B.C. 5 or 6. But there are other data from which calculations of the year of the Nativity have been made, viz.: (*b*) the appearance of the star; (*c*) the census by Augustus; (*d*) the age at the baptism; (*e*) the date of the first Passover after the baptism; (*f*) the succession of the courses of the priests. Of these it is sufficient here to observe that there is not one of them that yields a certain result.

As I have now proved that the date of the Nativity, commonly received since the time of *Dionysius Exiguus*, is inaccurate, I shall subjoin a precis, from "Hales' Chronology," of the different dates that have been accepted:

EPOCHS OF THE NATIVITY.	U.C.	B.C.
Tillemont, Mann, Priestly	747	7
Kepler, Capellus, Dodwell, Pagi	748	6
Chrysostom, Petavius, Prideaux, Playfair, Hales	749	5
Sulpitius Severus, Usher	750	4
Irenæus, Tertullian, Clemens Alex., Eusebius, Syncellus, Baronius, Calvisius, Vossius	751	3
Epiphanius, Jerom, Orosius, Bede, Salian, Sigonius, Scaliger	752	2
Chronicon Alexand., Dionysius, Luther, Labbæus	753	1
		A.D.
Herwart	754	1
Paul of Middleburgh	755	2
Lydiat	756	3

[Clinton adopts 5 B.C. as the year of the Nativity.]

At present, in the West, December 25th is regarded as the day set apart for the commemoration of the birth of Christ, but for the first

three hundred years it was celebrated on the day of the Epiphany From the authorities cited by Gieseler, i., p. 292, it appears that it was first appointed by Julius, Bishop of Rome, A.D. 337–352. See Mommsen, *Corpus Inscriptionum Latinarum*, Vol. I., p. 410, who cites the words of *scriptor Syrus* (apud Assemannum bibl. Oriente, V. II., p. 164): "*Causa ob quam mutarunt patres solemnitatem die 6 Jan.* [*i. e.*, Epiphaniæ die] *et ad diem 25 Decembris transtulerunt, hæc fuit: solemne erat Ethnicis hoc ipso 25 Decembris die natalicia solis celebrare, in quibus accenderunt lumina festivitatis causa. Horum sollemnium et festivitatum etiam Christiani participes erant. Cum ergo animadverterent doctores ad hoc festum propendere Christianos, consilio inito statuerunt hoc die vera natalicia esse celebranda, die vero 6 Jan. festum Epiphaniorum. Hic itaque una cum hoc instituto ad diem usque sextum invaluit mos ignium accendendorum.*"

In the *Fasti Philocali*, the day VIII · K · IAN · (*i.e.* Dec. 25) is marked $\overline{\text{N}}$ · INVICTI · $\overline{\text{CM}}$ · XXX *i.e.*, N(atalis) invicti; c(ircenses) m(issus) xxx. *Invictus* is a common epithet of Mithras, or Sol, of whom, it is well known, Constantine the Great (Emperor from 306 to 327 A.D.) was a worshipper.

7—15,

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7. Plato, *Philebus*, 30 B. πᾶσαν καὶ παντοίαν σοφίαν ἐπικαλεῖσθαι.

The passage in which these words occur presents many difficulties, owing partly to the want of sequence in the grammatical structure of the sentences, partly to the obscurity of meaning. Professor Jowett somewhat freely renders, or rather paraphrases, this passage as follows: "For surely we cannot imagine that of the four classes, the finite, the infinite, the composition of the two, and the cause or fourth class, which enters into all things, giving to our bodies souls, and the art of self-management, and of healing disease, and operating in other ways to heal and organize; we cannot, I say, imagine that this last should *have all the attributes of wisdom*, and that whereas the elements exist, both in the entire heaven and *in great provinces of the heaven*, only fairer and purer, this should not also in that higher

sphere have designed the noblest and fairest of natures?" The *italics* are mine. In this rendering, which appears to present the opinions expressed in the notes of the commentators, there are several points to which I would direct attention. In the first place, it seems somewhat awkward that ἐπικαλεῖσθαι should be given a passive meaning (*appellari*), while μεμηχανῆσθαι, which is co-ordinate with it, is taken as active (*effecisse*). In the next place, I cannot help feeling that, thus taken, the sentence ἐν μὲν τοῖς παρ' ἡμῖν κ. τ. λ., is but a poor antithesis to ἐν τούτοις δὲ κ. τ. λ. I think that it should be translated somewhat in the following manner: "And operating in other ways to heal and organize, *summons to its aid every varied device of science.*" This would give ἐπικαλεῖσθαι its more usual meaning of "*calling in as helper, &c.*" Again, if the words κατὰ μεγάλα μέρη are to be rendered "in great provinces *of the heaven*" (τοῦ οὐρανοῦ being understood), we are told that the elements exist *both* in the *entire* heaven *and* in great provinces of the heaven. Such pleonasms are certainly idiomatic among the Greeks; but, one would think, should not be unnecessarily attributed to them. It would seem more in accordance with the context to render κατὰ μεγάλα μέρη "*in large quantities*," *i.e.*, these elements not only exist in the entire heaven but also in great abundance there. They are moreover as superior in quality as in quantity to ours.

8. *Ibid.*, 42 C. τούτων τοίνυν ἑξῆς ὀψόμεθα, ἐὰν τῇδε ἀπαντῶμεν, ἡδονὰς καὶ λύπας ψευδεῖς ἔτι μᾶλλον ἢ ταύτας φαινομένας τε καὶ οὔσας ἐν τοῖς ζώοις.

Commentators usually put a comma after ἀπαντῶμεν, to avoid making the accusative ἡδονάς depend upon it, and supply a dative after ἀπαντῶμεν. Stallbaum, however, shows that there is no need for resorting to this artifice, as there are numerous examples of similar verbs with an accusative instead of the dative. But it has occurred to me that this passage is susceptible of a very different explanation. From a comparison with a passage immediately preceding this (41 B), where Socrates says, "Let us stand up, then, like wrestlers to this new argument," I am inclined to think that here, too, we have one of those metaphors from the training school, which one not unfrequently meets with in the dialogues of Plato (cp. *Phileb.* 13 D, and Stallbaum's note on that passage). Instead, then, of rendering this passage, with Professor Jowett, "Next let us see whether in another direction we may not find pleasures and pains existing and appearing in living beings, which are still more false than these," I would render,

"Next, then, we shall see, *if we join issue in this way*, pleasures and pains," &c. The surprised and indignant ποίας δὴ καὶ πῶς λέγεις; with which the defender of pleasure greets this home thrust, shows that the dialogue has not yet reached that easy didactic stage at which any suggestion unfavourable to his client will be suffered to pass unquestioned.

9. Sophocles, *Ajax*, v. 416. τοῦτό τις φρονῶν ἴστω.

These words are generally supposed to be equivalent to "*hoc sciat qui sapit*," "Let him who is wise know this." In this case, they serve as a cue to the spectators. In order to see their force, it is necessary to bear in mind the stage at which they are uttered. Ajax has just recovered consciousness, and, after an outburst of despair, in which, like Shakespeare's Duchess of Gloster (*Henry VI.*, pt. ii., act iv., sc. iv.), he declares that henceforth "dark shall be *his* light and night *his* day," and accuses all nature of being in league with his foes—"long has it kept him about Troy, where he has won nothing but dishonour, but no longer shall it keep him in life"—he exclaims, τοῦτό τις φρονῶν ἴστω—"This let me while in my right mind resolve." As I take it, Ajax fears that he may again relapse into frenzy, and work yet more "sorrow for his friends and laughter for his foes;" he will therefore make up his mind, while yet free from madness, to die. With regard to this interpretation, I would observe that φρονῶν is repeatedly used with this signification in the *Ajax*, *e. g.*, vv. 82 and 342; and τις is often used, like our "one," not only for the second and third, but also for the first person (cp. v. 245 of this play), especially where there is a hint of something unpleasant which is likely to happen to the person indicated—as, for instance, in the ludicrous scene between Dionysus and Xanthias, in the *Frogs* of Aristophanes (vv. 606, 628 and 664).

10. Cicero, *De Legibus*, II. xxv. 62. "Gaudeo nostra iura ad naturam accommodari maiorumque sapientia admodum delector; sed re[cedo] quiro, ut ceteri sumptus, sic etiam sepulchrorum modum. MARCUS. Recte requiris."

In this passage, which I have given according to Vahlen's text (as being that which adheres most closely to the MSS.), the chief difficulty lies in the words *sed recedo quiro*, which are said to be thus given in those MSS. which are generally considered to be of highest authority. Vahlen's remedy would appear to be the least violent of those proposed; he would read *sed requiro*. Halm, Klotz, and Feld-

hügel, assign to Marcus those words which follow *delector*. Thus they read: "MARCUS. *Sed credo, Quinte, ut c. s., sic etiam s. m. recte requiri.*" Either of these readings fails to account for the presence of several letters in the MSS. The following reading appears to me to be free from objection on this score: *delector; sed recte, credo, requiro . . . . modum.* M. *Recte requiris.* With regard to the emendation here proposed, it is necessary to remark that *recte credo* would degenerate into *recedo* through one of the most frequent sources of corruption in MSS., viz., the confusion of the letters *t* and *c*; it would be superfluous to adduce examples of this well known fact. Another step in this progress of error would be the omission, almost regular in MSS., of recurrent letters, which would account for the disappearance of *ct* and *e*; and, finally, the letter *r* being indicated, rather than written, by a dash, would readily escape notice. Thus the word *progressa*, which immediately follows, is said to be given as *pcessa* or *processa* in the best MSS.

11. *Ibid.*, II. xxv. 63. Here Vahlen gives the reading of the best MSS. as "*Nam et Athenis iam* illo mores *a Cecrope, ut aiunt, permansit hoc ius terra humandi.*" He proposes *nam et Athenis*, (*nostis*) *iam illos mores, &c.* The reading given in the text of Nobbe, Klotz, and Halm—*nam et Athenis ille mos a Cecrope, &c.*—is said to be found as an interlinear correction of the MSS. Halm, however, in a foot note, speaks of the passage as a *locus nondum sanatus.* A statement which Madvig makes in his *Adversaria* (Vol. I., p. 40), that the words *mores* and *maiores* are occasionally interchanged in MSS., suggested what I conjecture to have been the original reading, namely: *Nam et Athenis iam illo a Cecrope, maiores ut aiunt, &c.* "For at Athens too, even from the time of the famous Cecrops, as the ancients say, &c." The confusion of *maiores* with *mores* would lead naturally to this transposition of the words. The age of Cecrops would appear to have passed into a proverbial expression for the remotest antiquity, the words *ut aiunt* being regularly used in quoting a proverb.

12. Virgil, *Georgics*, B. III., v. 348.

> "Omnia secum
> Armentarius Afer agit, tectumque Laremque
> Armaque Amyclæumque canem Cressamque pharetram:
> Non secus ac patriis acer Romanus in armis
> Injusto sub fasce viam quum carpit, et hosti
> Ante expectatum positis stat in agmine castris."

On this passage Conington remarks that "Keightley seems right in saying that *in agmine* ought to have been strictly *in acie.* There may be some rhetorical point in the catachresis to show the rapidity with which the line of march is exchanged for line of battle." I think that it is possible to give *agmine* its proper meaning, without assuming any catachresis. The heavy burden of stakes under which the Roman soldier is described, in the preceding line, as toiling along, would enable him, as Conington says, to exchange with rapidity the line of march for line of battle. As I take it, the idea conveyed is, that an enemy surprises the Romans while on the march; instantly each man plants his stakes, and, to the amazement of the enemy, there is a stockade to storm instead of a column with unprotected flanks. This may be brought out, I think, without difficulty, by laying stress on *agmine.* I would render thus: "Not otherwise than when the brave Roman in the arms of his fathers, beneath an unequal burden wends his way, and unexpectedly, with pitched camp confronts the foe, *though on the march.*" Perhaps, however, it is better to make *hosti* depend upon *expectatum;* in which case the force of *et* will be more apparent; thus, "when, beneath an unequal burden, he wends his way; *and suddenly,* all unexpected by the foe, stands with pitched camp *though on the march.*"

13. Juvenal, *Satire* XIII., v. 197.

> "Poena autem vehemens ac multo saevior illis,
> Quas et *Cædicius* gravis invenit aut Rhadamanthus,
> Nocte dieque suum gestare in pectore testem."

Who the Cædicius here mentioned was, the commentators are unable to discover. The scholiast, as usual, makes a guess, and gravely states that Cædicius was either a cruel judge, or something else, in the reign of Nero. It strikes me that the name is one coined from the verb *cædo,* in which case it would be pretty nearly equivalent to "strike-'em." Thus it would do duty either for the "Jack Ketch" of the day, or for the cruel Draco of antiquity.

14. Propertius, V. ix. 5.

> "Qua *Velabra* suo stagnabant flumine, quaque
> Nauta per urbanas velificabat aquas."

We have here one of those amusing attempts at derivation, in which the ancients were fond of indulging. Mr. Paley has the following note on this passage: "*Velabra.*—The low part of the city called the Velabrum is here derived from *vela,* on the theory that it was once,

like the place called λίμναι, at Athens, stagnant water. See on V., 2, 8. Varro, L.L., V., § 43–44: 'Olim paludibus mons (Aventinus) erat ab reliquis disclusus, itaque ex urbe advehebantur ratibus, quoius vestigia, quod ea, qua tum vehebantur, etiam nunc dicitur Velabrum.'—'Velabrum a vehendo. Velaturam facere etiam nunc dicuntur, qui id mercede faciunt.'"

There seems to be no doubt, from the above and similar passages (*e. g.*, Ovid, *F.*, VI., 505), that the Velabrum was originally a marshy spot. It has occurred to me that a more satisfactory derivation than either of those given above, would be to suppose it connected, by the medium of the digamma, with the Greek ἕλος, "a marsh;" and if, as philologists suppose, the Latin *vallis* is of cognate origin with ἕλος, this example would greatly add to the probability of the derivation which I propose. With regard to the termination of *Velabrum*, possibly, as in *volutabrum*, it is a mere suffix; possibly, as in *candelabrum*, the termination, *brum*, retains the meaning of the root *BHAR* (found in φέρω, *fero*, &c.), "bear," with which it is generally supposed to be connected. In this case, *Velabrum* would be, "The ferry of the marsh;" and the old derivation from *veho* would not be so far wrong after all.

15. *Luscinia.* This word is variously derived in the Lexica:

(1) *luscus* and *cano*, "the bird singing at night."

(2) *lux* and *cano*, "the bird singing at dawn."

(3) λύω and *cano*, "the liquid songstress."

Of these derivations the first is commonly rejected, on the ground that *luscus* and *cano* would properly signify "the one-eyed songstress;" the second, because the bird does not sing merely at daybreak but all the night long, and frequently in the daytime too.

With regard to the third, which has been received with more favour, I would object that, in almost every passage where the nightingale is mentioned by the ancients, it is not the sweetness but the sadness of her song which appears to have impressed them. Why did this bird redouble her plaints during the night, when other birds of song were still and silent? The myth of Philomela, Procne, and Tereus (Ovid, *Metam.* VI. 424 foll.) furnished an answer to this question. Everywhere the nightingale, whether called Procne, Philomela, or ἀηδών, is used as a symbol of ceaseless mourning. Sophocles speaks of her as the frantic mourner, whose unending plaint of "Itys ever Itys," best accords with the melancholy fancy of the forlorn

Electra. *'Αλλ' ἐμέ γ' ἁ στονόεσσ' ἄραρεν φρένας, Ἃ Ἴτυν, αἰὲν Ἴτυν ὀλοφύρεται, ὄρνις ἀτυζομένα.* (Sophocles, *Electra*, v. 147.)

Æschylus (*Agamemnon*, vv. 1110 foll.) puts similar language into the mouth of the Chorus with regard to Cassandra's dirge. The name Itys is, of course, an onomatopœia. It is superfluous to multiply examples; a few of the more striking ones will serve our purpose. In addition to those mentioned above, we may take Homer, *Odyssey*, B. XIX., v. 522; Catullus, Ode LXV., v. 14; Virgil, *Georgics*, B. IV., v. 514.

In all these passages it is the *infelix avis*, the "hapless bird," which is present to their thoughts. From these considerations I have been tempted to propose *δυς* and *cano* as a probable derivation. *Dus* is the prefix which we find in the compounds *δυσηχής*, *δύσθροος* and other words, with the notion of "hard, bad, unlucky, &c." The letters *d* and *l* are, as is well known, interchangeable, cp. *e.g.* *δάκρυμα* and *lacruma* "a tear." Thus *luscinia* would be the "plaintive songstress."

EULER'S EQUATIONS OF MOTION.

BY JAMES LOUDON, M.A.,
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1. A rigid body fixed at O has at time t rotations $\omega_1\ \omega_2\ \omega_3$ round the principal axes OA, OB, OC: to determine the changes per unit time in these rotations.

The positions OA', OB', OC' of the axes at time $t+\delta t$ will be known from the displacements in time δt, due to these rotations, of the points $A\,(\omega_1, 0, 0)$, $B(0, \omega_2, 0)$, $C(0, 0, \omega_3)$. The components of these displacements in the directions OA, OB, OC, respectively, are evidently

$$\begin{array}{cccl} 0, & \omega_1\omega_3\delta t, & -\omega_1\omega_2\delta t, & \text{for } A; \\ -\omega_2\omega_3\delta t, & 0, & \omega_1\omega_2\delta t, & \text{for } B; \\ \omega_3\omega_2\delta t, & -\omega_3\omega_1\delta t, & 0, & \text{for } C. \end{array}$$

The component rotations at time $t+\delta t$ are $\omega_1 + \dfrac{d\omega_1}{dt}\cdot\delta t$, &c., which may be represented by OA', OB', OC'. The changes of the rotations in time δt are therefore AA', BB', CC'. Resolving these changes into the components (AF, FP, PA'), (BG, GQ, QB'), (CH, HR, RC'), in the directions of the axes at time t, we get (observing that FP, PA' are the displacements in time δt of the point $F\ (\omega_1 + \dfrac{d\omega_1}{dt}\delta t, 0, 0)$, &c., and neglecting infinitesimals above the first order) the following as the resultant changes in time δt:

$$AF + GQ + HR = \left(\frac{d\omega_1}{dt} - \omega_2\omega_3 + \omega_3\omega_2\right)\delta t = \frac{d\omega_1}{dt}\delta t \text{ along } OA;$$

$$FP + BG + RC' = \left(\omega_1\omega_3 + \frac{d\omega_2}{dt} - \omega_3\omega_1\right)\delta t = \frac{d\omega_2}{dt}\delta t \text{ along } OB;$$

$$PA' + QB' + CH = \left(-\omega_1\omega_2 + \omega_2\omega_1 - \frac{d\omega_3}{dt}\right)\delta t = \frac{d\omega_3}{dt}\delta t \text{ along } OC.$$

The changes per unit time are therefore $\dfrac{d\omega_1}{dt}$, $\dfrac{d\omega_2}{dt}$, $\dfrac{d\omega_3}{dt}$, in the directions OA, OB, OC, respectively.

2. To determine the component changes of the body's moment of momentum.

At time t the components of the moment of momentum are $A\omega_1$, $B\omega_2$, $C\omega_3$ in the directions of the principal axes, where A, B, C denote the principal moments of inertia. At time $t + \delta t$ the components are $A\left(\omega_1 + \frac{d\omega_1}{dt}\delta t\right)$, &c., in the directions OA', OB', OC'. Employing the figure in a new sense, the former components may be represented by OA, OB, OC, and the latter by OA', OB', OC'. The changes of the moment of momentum in time δt are therefore AA', BB', CC'. Resolving these changes into their components parallel to the axes at time t we get, as in the former case, (observing that FP, PA' are now the displacements in time δt of the point F $\left(A\omega_1 + A\frac{d\omega_1}{dt}\delta t, \text{o}, \text{o}\right)$, &c.), the following as the resultant changes of the moment of momentum in time δt:

$$\left(A\frac{d\omega_1}{dt} - B\omega_2\omega_3 + C\omega_3\omega_2\right)\delta t \text{ along } OA;$$

$$\left(A\omega_1\omega_3 + B\frac{d\omega_2}{dt} - C\omega_3\omega_1\right)\delta t \text{ along } OB;$$

$$\left(-A\omega_1\omega_2 + B\omega_2\omega_1 + C\frac{d\omega_3}{dt}\right)\delta t \text{ along } OC.$$

The changes per unit time are therefore $A\frac{d\omega_1}{dt} - (B - C)\,\omega_2\omega_3$, &c., in the directions OA, OB, OC, respectively.

NOVEMBER 21st, 1878.

TIME-RECKONING.

BY SANDFORD FLEMING, C.M.G., M. INST. C.E., F.G.S., F.R.G.S., LIFE M.C.I., ETC.
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I propose to direct the attention of the Institute to some points connected with the reckoning of time. I shall refer to the minor inconveniences which in all parts of the world are daily experienced. I shall likewise point out what strike me as the more serious difficulties arising from our present notation, and which the progressive character of the age is gradually developing. The importance of determining some means by which these inconveniences may be overcome, cannot fail to be admitted by all who recognize the presence of the difficulties of which I speak.

The subject, by its character, cannot be limited in its bearing to Canada, or indeed to any country. It is one which affects in different degrees every locality and individual on the face of the earth; and it is of particular importance to all countries in which civilization is making rapid strides, and of which the geographical features resemble those of Canada and the United States.

I propose to consider the subject under the following aspects:

1st. The difficulties which arise from the present mode of reckoning time, owing to the extension of telegraph and steam communications by land and water.

2nd. The natural and conventional divisions of time.

3rd. The systems of reckoning time, ancient and modern.

4th. The necessity of meeting the defects caused by present usages, and the useful results which would be obtained from a uniform non-local system.

5th. The practicability of securing all the advantages attainable from uniformity, without seriously interfering with existing local customs.

The division of the day into two halves, each containing 12 hours, and each numbered from 1 to 12, is a fertile source of error and inconvenience.

Travellers who have had occasion to consult railway guides and steamboat time-tables, will be familiar with the inconvenience resulting from this cause; none know better by experience how much the divisions *ante meridian* and *post meridian* have baffled their inquiries, and how often these arbitrary divisions have led to mistakes. Were it necessary, innumerable instances could be given. The evil however is one so familiar that it has come to be looked upon as unavoidable, and is, as a matter of course, silently endured.

The halving of the day has doubtless long been in use, but beyond its claim to antiquity, is a custom that confers not a single benefit, and is marked by nothing to recommend it.

Another more serious difficulty, forced on the attention by the science of the century, is mainly due to the agency of electricity, employed as a means of telegraphy; and to steam applied to locomotives. These extraordinary sister agencies having revolutionized the relations of distance and time, having bridged space, and drawn into closer affinity portions of the earth's surface previously separated by long and, in some cases, inaccessible distances.

Let us take the case of a traveller in North America. He lands at Halifax in Nova Scotia, and starts by a railway to Chicago through the eastern portions of Canada. His route is over the Intercolonial, the Grand Trunk, and other lines. He stops at St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton and Detroit. At the beginning of the journey he sets his watch by Halifax time. As he reaches each place in succession, he finds a considerable variation in the clocks by which the trains are run, and he discovers that at no two places is the same time used. Between Halifax and Chicago he finds the railways observing no less than seven different standards of time. If the traveller remains at any one of the cities referred to, he must alter his watch to avoid inconvenience, and perhaps not a few disappointments and annoyances to himself and others. If, however, he should not alter his watch, he would discover on reaching Chicago that it was an hour and thirty-five minutes faster than the clocks and watches in that city.

If his journey be made by one of the routes through the United States, the variation in time and its inconveniences will not be less.

If he extends his journey west of Chicago, travelling from place to place until he reaches San Francisco, he will meet continual change, and finally discover a loss in time of nearly four hours (3h. 56m.). Between the extreme points there are many standards of time, each city or place of importance generally being governed by its own meridian. Hence the discrepancies which perplex the traveller in moving from place to place.

On the continent of Europe, and indeed wherever lines of communication extend between points differing to any considerable extent in longitude, the same difficulty is experienced. On a journey from Paris to Vienna or to St. Petersburg, the standard time employed by the railways changes frequently, and the extreme difference in time between the first and last city is nearly two hours. As railways and telegraphs are extended in Russia, the inconveniences will become of serious importance in that country. Within the limits of Russia in Europe and Asia, the extreme variations of time is about twelve hours.

Suppose we take the case of a person travelling from London to India. He starts with Greenwich time, but he scarcely leaves the shores of England, when he finds his watch no longer right. Paris time is used for the journey, until that of Rome becomes the standard. At Brindisi there is another change. Up the Mediterranean, ships' time is used. At Alexandria, Egyptian time is the standard. At Suez, ships' time is resumed, and continues, with daily changes, until India is reached. Arriving at Bombay, the traveller will find two standards employed, local time and railway time, the latter being that of Madras. If he has not altered his watch since he left England, he will find it some five hours slow. Should he continue his journey to China, it will have fallen eight hours behind.

In the United Kingdom the difficulties due to longitude are only felt in a modified form. The greater island, embracing England and Scotland, is comparatively limited in width; one standard of time is therefore used. It is only in respect to the sister island, Ireland, that the difference in longitude calls for a difference in time. In the whole United Kingdom, consequently, there are practically only two standards, viz., Greenwich time and Irish time, the difference being twenty-five minutes. No one, therefore, whose experience has been confined to the United Kingdom, can form an adequate idea of the extent of the inconvenience arising from the causes alluded to,

where geographical circumstances render necessary the use of a multiplicity of standards.

The railway system is the principal agent in the developing of the difficulties referred to, and the still further extension of steam communications in great continental lines is forcing the subject on public attention. Canada supplies a good illustration of what is occurring. The railways built and projected will extend from the eastern coast of Newfoundland on the Atlantic, to the western coast of British Columbia on the Pacific, embracing about seventy-five degrees of longitude. Every Canadian city has its own time. Innumerable settlements are now being formed throughout the country ultimately to be traversed by railways; and in a few years, scores of populous towns and cities will spring up in the now uninhabited territories between the two oceans. Each of these places will have its own local time; and the difference between the clocks at the two extremes of Canada will be fully five hours. The difficulties which will ultimately arise from this state of things are apparent. They are already in some degree felt, they are year by year increasing, and will at no distant day become seriously inconvenient. This is the case not in Canada alone, but all the world over.

Again, there is a difficulty with regard to the determination of not only the precise hour, but even the day, of any occurrence under our present system of reckoning.

Persons who inhabit different sections of the earth, differ from each other in their reckoning of the day. At one place it is noon, at another it is midnight; at a third it is sunrise, at a fourth it is sunset. In consequence we have the elements of confusion, which involve in some cases the mistake of a whole day.

People even living in the same meridian may differ a day in their usual reckoning of time, according as the countries they inhabit have been colonized from the one side or the other of the globe. There are instances in the Pacific Ocean where islands almost adjacent reckon by different days of the month and week; a circumstance calculated to produce much confusion when intercourse becomes frequent.

In Alaska the days of the week and month were one day in advance of those in the adjacent colony of British Columbia, indeed of the whole of America. On the advent of citizens of the United States a few years ago, when that territory was transferred by Russia,

the Saturday was found to be the Sunday of the old residents. For ordinary business purposes a change became necessary, and a dispensation was granted in 1871 by the dignitaries of the Greek Church in Russia, authorizing their missionaries and adherents in Alaska to celebrate Sunday a day later, or on Monday, according to the old reckoning.

The reverse has been met in another quarter of the globe. The Philippine Islands, lying between Australia and Asia, and about 100 degrees of longitude to the west of Alaska, were discovered in 1521 by the illustrious Magellan in his memorable first circumnavigation of the globe. That navigator followed the sun in his path around the world. Legáspi succeeded him and took possession of these important Islands in the name of Philip II., king of Spain. The Philippine Islands extend for a thousand miles from north to south, they embrace Manilla, one of the oldest cities of the Indies, and they contain a population of 5,000,000. They were colonized, as well as discovered, by Spaniards coming from the east; and as a consequence the reckoning of the inhabitants has for more than three centuries remained a day behind the day in British India and the neighbouring countries in Asia.

Travellers who arrive at New Zealand or the Australian colonies, by the San Francisco route, meet the same difference, owing to the fact that the countries in the South Pacific were colonized from the west. The day of the week and of the month carried from San Francisco, never agrees with the day and date reckoned by the inhabitants at the destination of the steamer.

All travellers who have made the voyage between America and Asia have experienced the difficulty in reckoning referred to. Those who have proceeded westward have lost, while those who have travelled eastward have gained a day. In Mrs. Brassey's "Around the World in the Yacht 'Sunbeam,'" this experience is recorded. The journal of that lady passes from Wednesday, January 10th, directly to Friday, January 12th—Thursday, January 11th, having no existence with the travellers.

In sailing across the Pacific from west to east, one day has to be repeated before landing on the American coast. If, for example, the correction be made on Wednesday, 1st July, there will be two Wednesdays in the one week, and two days of the month dated July 1st.

A journey round the world is now an everyday undertaking, and is accomplished with comparative ease. Suppose two travellers set out from a given place, one going eastwardly, the other westwardly. A singular circumstance will result when they both return to the common starting point, and the reason is obvious. One man will arrive, according to his reckoning, say on Tuesday, 31st December, when in fact at that locality it is Wednesday, January 1st. The other traveller, assuming that he has kept accurately a daily journal, will enter in his diary on precisely the same day, Thursday, January 2nd. This consequence has been brought out by Edgar Allan Poe, in his amusing story of "Three Sundays in one Week," but it no longer can be held to be an imaginary contingency, since steam communication by land and water is now affording extraordinary facilities for making the tour of the globe.

To illustrate the difficulty more particularly. First, let us select points in four quarters of the globe, each about ninety degrees apart—say in Japan, Arabia, Newfoundland and Alaska. If we assume it to be Sunday midnight at the first mentioned place, it must be noon at the opposite point, Newfoundland, but on what day is it noon? Arabia being to the west of Japan, the local time there will be 6 p.m. on Sunday; and Alaska, lying to the east of Japan, the time there will be 6 a.m. on Monday. Again, when the clock indicates 6 p.m. on Sunday in Arabia, it must be Sunday noon at a point ninety degrees further west, or at Newfoundland; when it is 6 a.m. on Monday at Alaska, it must be noon on Monday ninety degrees further east, also at Newfoundland. Thus, by tracing local time east and west from a given point to its antipodes, the clock on the one hand becomes twelve hours slower, on the other hand twelve hours faster. In the case in point, while it is midnight on Sunday in Japan, at precisely the same moment it is noon at Newfoundland on two distinct days, viz., on Sunday and on Monday.

Secondly, let us trace local time only in one direction around the earth. The day does not begin everywhere at the same moment. Its commencement travels from east to west with the sun, as the earth revolves in the opposite direction, and it takes an entire revolution of the globe on its axis for the day everywhere to be entered on. Immediately on the completion of one revolution the inception of any one day ends, and at this moment the end of the day begins; and the globe must make another complete revolution before the end

of the day entirely finishes. The globe must in fact make two entire revolutions before any one week day runs out, consequently each and every day of the week runs over 48 hours; and, taking the whole globe into account, two civil days always co-exist. The first 24 hours of one day co-exist with the last 24 hours of its predecessor, while the remaining 24 hours co-exist with the first 24 hours of the day which follows.

It is difficult to accept the fact that any one day lasts more than 24 hours; but it can be demonstrated that it is the case. Let us place together several maps of the world on Mercator's "Projection," so as to represent, in consecutive order, each part of the earth's surface as it passes the sun during several diurnal revolutions. (*See Plate*).

AA^1, A^1A^2, and A^2A^3, are intended to represent each a complete map of the world. Within each of these limits every place on the earth's surface is brought under the sun during a daily revolution.

The vertical lines *E I N R V* represent meridians, for the sake of simplicity selected 60° degrees apart, and the stars or dots at their intersection denote the beginning and end of a day on each of the six meridians. As the earth revolves, the sun passes successively the meridians of those localities, with an interval of four hours elapsing between each.

Let us assume it to be 12 o'clock midnight on Thursday at meridian *A*. At that moment and at that place Friday begins and runs for 24 hours, or on the diagram from *A* to A^1.

Four hours later Friday begins on meridian *E*, and runs four hours on the second map, or into the 2nd revolution of the earth. Four hours still later Friday begins on meridian *I* and runs eight on the second map or into the 2nd revolution. This goes on from spot to spot, until at last the commencement of Friday reaches the last meridian, and at that point Friday runs entirely across the second map to A^2. Thus Friday begins at *A*, runs during two complete revolutions of the earth, as shown on the map from *A* to A^2.

The diagram will thus illustrate the duration of every day in the week, and it becomes obvious, when we take a general view of the whole globe on any given day, say Saturday, that day begins in the middle of Friday and does not end until the middle of Sunday. Friday, on the other hand, beginning in the middle of Thursday, runs into the middle of Saturday, while Sunday commences at the moment Friday ends. To state the case differently: the same moment

of absolute time which is part of Saturday in one place, is equally part of Friday and of Sunday in some other places east and west.

It is a preconceived idea with many that there is a simultaneous Sunday over the earth, and that Christians in every meridian keep the Lord's day at one and the same time. Facts, however, establish that this is a mistake. From its first commencement to its final ending, the Sunday extends over 48 hours. Indeed, if we take into account the remarkable circumstance mentioned with regard to Alaska and the Philippine Islands, Sunday has been discovered to run over some 55 hours. The same may be said of any day in the week; and as a consequence we have, taking the whole globe into view, Saturday and Monday running over the intervening Sunday to overlap each other about seven hours. We have in fact as a constant occurrence, portions of three consecutive days co-existent.

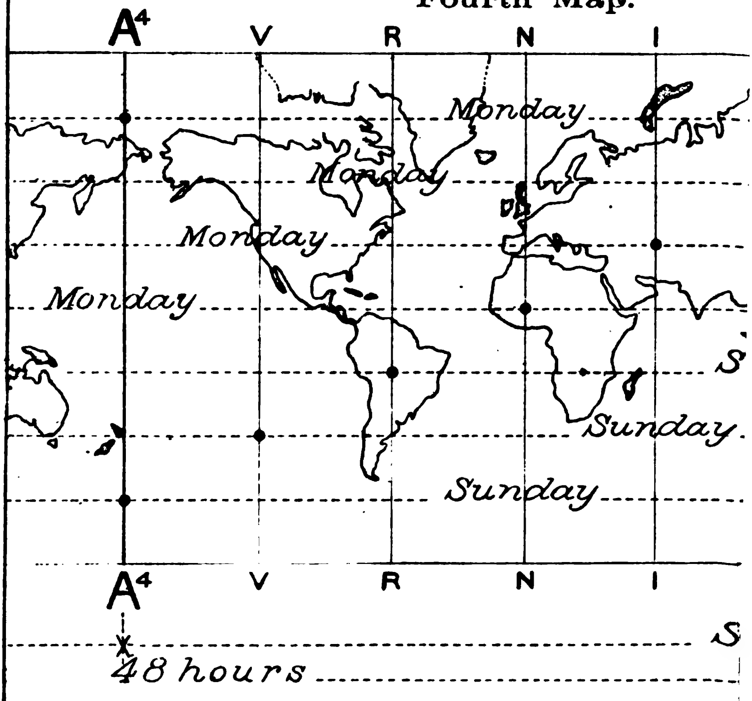
From the fact that not only are the hours of the day different in every meridian, but that different days are constantly in progress on the face of the globe, it is a difficult matter under our present system of reckoning to assign relatively the hour and day when events take place. We may learn of an occurrence, and the time assigned will be correct in the meridian of the locality. Everywhere else it will be inaccurate. Indeed, if the fact of the occurrence be transmitted over the world by telegraph, it may, in some places, be recorded on different days.* If the incident occurs at the close of a month, or a year, it may actually take place in two different months, or two distinct years.

Under our present system it is quite possible for two events to take place several hours apart, the first and older occurring in the new year in one locality; the second, although the more recent in absolute time, falling, in another locality, within the old year. The same may be said of events that occur during the period which elapses when one century merges into another. In one part of the globe the same event may transpire in the nineteenth century, while in another it falls within the twentieth century.

These explanations set forth the inconveniences and the ambiguity inseparable from the ordinary mode of reckoning. The system, besides being unscientific and inconvenient, must, as time rolls on, inevitably lead to countless mistakes. In fact, unless the geographical

* TIME AND THE TELEGRAPH.—A message dated Simla, 1.55 A.M. Wednesday, was received in London at 11.47 P.M. on Tuesday. As the clerk said, with pardonable confusion, "Why, this message was sent off to-morrow."—*Times.*

Fourth Map.



A4
V
R
N
I
Monday
Monday
Monday
Monday
S
Sunday
Sunday
A4
V
R
N
I
S
48 hours

position be specified as an important element of the date, there can be no absolute certainty with regard to time, as we at present note it in ordinary civil affairs.

The day is a purely local phenomenon. It begins and ends at every spot on the circumference of the globe at different instants in absolute time. From its very nature, there are as many different local days as there are points differing in longitude; and in order to make any comparison of the dates of different countries with each other, it is necessary, as in astronomical calculations, to make additions or deductions for the longitude of the places of observation. It need scarcely be argued that this process must become an exceedingly troublesome matter in the ordinary business of the world, especially when rapid and frequent intercourse between remote sections becomes general.

I need not further refer to the objections urged against the modes of keeping time, handed down to us from bygone centuries. It is clear from all experience that the customs which we still cling to, are indifferently adapted to the circumstances of the age, and that some better means of reckoning and verifying dates will soon be, if they are not already, urgently demanded.

A remedy for the evils to which your attention is directed may not generally be felt to be a pressing necessity; but the problem is obviously of no limited importance to the generation which is to succeed us, and it is not now too soon to seek for its solution. The minor inconveniences alluded to may be overcome in independent localities, as necessity dictates some arbitrary compromise; but if each country spontaneously adopted its own remedy, a want of uniformity of system, it is to be feared, will result, and increase the confusion.

The major difficulties to which I have referred are more general in their character, and in seeking for a remedy, uniformity of system is held to be of first importance, and consequently the broadest cosmopolitan view should be taken.

It is to be feared that no immediate solution to the problem may be possible; but a general inquiry into the science of chronometry may suggest means by which the difficulties may in some degree be met.

NATURAL AND ARTIFICIAL DIVISIONS OF TIME.

Time is determined in nature by the motions of the heavenly bodies. The great natural divisions are three in number: the year,

the lunar month, and the day. All other divisions of time, as the civil month, the week, the hour, the minute, and the second, although long in general use, are arbitrary, conventional and artificial.

The employment of the lunar month for reckoning time is not general, although some nations, such as the Turks, Jews and Chinese, have preferred a lunar chronology. In China the age of the moon and the day of the month are identical.

The period measured by the diurnal movement of the earth on its own axis constituted the first space of time reckoned by the human race, and is undoubtedly the most important to man in all stages of civilization. It involves the most familiar phenomena of light and darkness, and embraces the constantly recurring periods of wakefulness and sleep, of activity and rest.

A day is the shortest measure of time afforded by nature. It is denoted by the revolution of the earth, and although the motion of the earth is uniform, we have three kinds of natural days all varying in length—the solar, lunar, and sidereal.

A solar day is the period occupied by a single revolution of the earth on its axis in relation to the sun.

A lunar day is the interval of time occupied by a revolution of the earth on its axis in relation to the moon.

A sidereal day is the period required for a complete revolution of the earth on its axis in relation to any one fixed star.

Of these three natural days, the sidereal day is the only one uniform in length. The lunar day, on account of the irregular and complicated motion of the moon in the heavens, is never employed as a measure of time. The solar day is variable in length on account of the ellipticity of the earth's orbit. Solar time is that shown by a sun-dial.

Although the sidereal day is uniform in length, inasmuch as it has no relation to the daily return of light and darkness, it is not employed for civil purposes. The commencement of the sidereal day is constantly changing throughout the year; at one period it comes at midnight, at another period at high noon.

It has been found convenient, therefore, to establish an artificial day, uniform in length, designated the mean solar day.

The mean solar day, as its name implies, is the average length of all the natural solar days in a year, and is the time intended to be indicated by ordinary clocks and watches.

The natural solar day is at one season of the year 14 minutes 32 seconds shorter, and at another 16 minutes 17 seconds longer than the mean. Thus the extreme variation is half an hour and 49 seconds.

The earth revolves in its orbit in about 365¼ days. To avoid fractions of days, it has been found convenient to establish three years in succession of 365 days, and each fourth year 366 days. The latter are designated leap years.

While an ordinary solar year has but 365 days, it has 366 sidereal days.

A solar day, therefore, exceeds the length of a sidereal by about $\frac{1}{365}$th part of a day, or nearly four minutes (3 minutes 55.9094 seconds).

The mean solar day, according as it is employed for civil or astronomical purposes, is designated the civil day, or the astronomical day. The former begins and ends at midnight; the latter commences and ends at noon. The astronomical day is understood to commence twelve hours before the civil day, but its date does not appear until its completion, twelve hours after the corresponding civil date. The two dates, therefore, coincide only during the later half of the civil and the earlier half of the astronomical day.

ANCIENT AND MODERN RECKONING OF TIME.

It has been stated that all shorter periods of time than a day are conventional and arbitrary, there being no measure less than a day denoted by nature. The only exception is the interval marked by the rising and setting of the sun; a period of time varying with the latitude and changing from day to day with the seasons.

The sub-division of the day into parts has prevailed from the remotest ages; though different nations have not agreed, either with respect to the epoch of its commencement, the number of the subdivisions, or the distribution of the several parts.

The division of the day with which we are most familiar is that which separates the whole space of time occupied by a diurnal revolution of the earth into two equal parts; one part extending from midnight to noon, the other part from noon to midnight. These half days are sub-divided into twelve portions or hours, and these again into minutes and seconds.

Astronomers do not divide the day into two sets of twelve hours. The astronomical day, extending from noon to noon, is reckoned by hours running from one to twenty-four.

In China and some other parts of the world, no half days are used. The Italians, the Bohemians and the Poles have a division of the day into twenty-four parts, numbered from the first to the twenty-fourth, from one o'clock to twenty-four o'clock. The Chinese divide the day into twelve parts, each being equal to two hours of our time; these they again divide into eight parts, thus sub-dividing the whole day into ninety-six equal parts. The Chinese astronomers, according to some authorities, divide the day into 100 parts, and each of these into 100 minutes, so that the whole contains 10,000 minutes. The inhabitants of Malabar have divided the day into six parts, each of these again into 60 parts. The ancient Tartars, Indians and Persians divided the day into eight parts, they had also a division of sixty parts.

In Japan there are four principal points of division—at noon, midnight, sunset and sunrise, dividing the natural day into four variable parts. These four parts are divided each into three equal portions, together making twelve hours. Each hour is again divided into twelve parts, thus making in all one hundred and forty-four subdivisions of the day. The six hours between sunrise and sunset differ in length, day by day, from the six hours between sunset and sunrise. During the summer the hours of the day are much longer than those of the night, and shorter, on the contrary, in the winter.

The division of that portion of the day during which the sun is above the horizon, into parts, belongs to the remotest ages of antiquity. The division of the other portion, which embraces the period of darkness, is of more recent date. It was not introduced at Rome until the time of the Punic Wars.

In early times the only divisions recognized were sunrise and sunset. Afterwards the division of the interval of daylight into two parts was made to denote mid-day. For many ages the Romans took no public notice of any point in the diurnal revolution of the earth, excepting mid-day. The precise time was manifested when the line of the sun's shadow fell along the forum in a particular direction, and the fact was duly announced by sound of trumpet.

Before mechanical means were adopted for the division of the day, only the vague, natural divisions of forenoon, afternoon, morning, evening and night could be used. Mention is made of the erection of the first sun dial at Rome by Papirius Cursor, 293 B.C., and the division of time into hours. The employment of sun dials led to a

singular consequence, the number of hours were made constant between sunrise and sunset, and instead of being equal in length, the hour varied with the length of daylight. Whatever the moments of sunrise and sunset, the interval of light was divided into 12 parts. If the sun rose at 4 a.m. and set at 8 p.m., according to our notation, each hour would be equal in length to 80 of our minutes. Old habits are so strong that this constantly varying system was adhered to long after mechanical time-keepers were introduced, and attempts were made to regulate clocks to tell the unequal hours. Like the Romans, the Greeks divided the intervals of light between sunrise and sunset, whatever its length, into 12 equal parts, subject to change from day to day. The custom of making the hours variable is still followed by some eastern nations.

The system of dividing the day by the rising and setting of the sun makes the hours indefinite periods, as they continuously change with the seasons. Except at the equinoxes, the hours of the night and day can never be of equal length. Near the equator the variations are least; they increase with every degree of latitude until the arctic and antarctic circles are reached, within which a maximum is attained. Even in the latitude of Rome, the length of the hours of daylight and darkness under this system have an extreme difference of 75 minutes. In Spitsbergen the sun sets about the beginning of November, and remains below the horizon for more than three months. It does not set for an equal period after the middle of May.

Sun dials had two great defects, they were unserviceable at night and during cloudy weather. The clepsydra or water clock was accordingly introduced at Rome about 158 B.C., by Scipio Nasica Corculum. It measured time by allowing water to escape through an orifice in a vessel, as sand flows through a modern sand glass. Subsequently some sort of toothed-wheel work was applied to the clepsydra by Ctesibius (A. D. 120). Diurnal and nocturnal time was measured in this or some other rude manner for many centuries. Besides sun dials, gnomons and clepsydræ, all of which appear to have been known to the Egyptians, Indians, Chaldeans, Babylonians and Persians long before their Introduction at Rome, mention is made of a contrivance by which a mechanical figure dropped a stone into a brazen basin every hour, producing a loud sound which for a great distance announced the divisions of time. King Alfred employed as a time-keeper six wax candles, each 12 inches long. Three

inches burned in about an hour, and thus the six candles lasted 24 hours, each being lighted in succession by an attendant. The system of measuring time by the burning of candles was subsequently used in monasteries. About the time of the eleventh century clocks moved by weights and wheels were first introduced. The pendulum clock was invented in the 17th century.

The Babylonians, Persians, Indians, Syrians, Greeks and other ancient nations, began their day at sunrise, and had divisions corresponding to morning, forenoon, mid-day, afternoon, evening and night. The Jews had four divisions, viz., evening, morning, noon and midnight, the two first being much longer than noon and midnight. The civil day of the Jews began at sunrise, their sacred day at sunset. The latter mode was followed by the Athenians and ancient Gauls.

The ancient, like the modern, Arabians began their day at noon.

The Chaldean astronomers divided the day into sixty parts; like the modern Chinese, they also had a division of the day into twelve hours.

The ancient Egyptians (probably B.C. 1000) divided the day equally into day and night, and again sub-divided each half into twelve hours, numbered from 1 to 12; the night with them commenced six hours before and terminated six hours after midnight; the day began six hours before noon and lasted twelve hours, or until six hours after noon. It is probable that the Egyptians had different modes of computing the day in different provinces. According to Pliny, they reckoned it from one midnight to another. The astronomers of Cathay and the East Indies reckoned it in the same manner. The Mohammedans from one twilight to another.

The day is reckoned to begin in China before midnight, the first hour extending from 11 p.m. to 1 a.m. of our mode of reckoning. The Jews, Turks, Austrians and others, with some of the Italians, have begun their day at sunset. The Arabians begin their day at noon, and in this respect they resemble the astronomers and navigators of modern nations. In Japan it has been customary to adhere to the practice of the ancient Babylonians in beginning their day at sunrise.

The above are some of the customs, gleaned from history, which have prevailed at various times in different countries with respect to the day and its sub-division. To these may be added the custom practised at sea by navigators. Mariners of different nations have had

different customs, but the most common practice on shipboard is to divide the 24 hours into six equal portions called "watches," and these again into eight equal parts known as "bells," and numbered from 1 to 8. Thus, the whole day is sub-divided into 48 equal parts. The period of time called a "watch" is four hours in length, the reckoning being as follows:

From noon to 4 p.m., the afternoon watch.
" 4 p.m. to 8 p.m, the dog watches (from 4 to 6 being the first dog watch; from 6 to 8 being the second dog watch).
" 8 p.m. to midnight, the first (night) watch.
" midnight to 4 a.m., the middle (or second night) watch.
" 4 a.m. to 8 a.m., the morning watch.
" 8 a.m., to noon, the forenoon watch.

This division into watches has a remarkable similarity to the practice followed by the Jews before the captivity. They divided the night into three watches, the first lasting till midnight, the middle watch lasting till cock-crow, the morning watch lasting until sunrise.

From what has been set forth, it would appear that the subdivisions of the day have not been less varied than the computations of the day itself. Man has reckoned the day to begin at sunrise, at sunset, at noon, at midnight, at twilight, at one hour before midnight, at six hours before midnight, and at six hours before noon. He has divided it in a great variety of ways, viz.: *First*, into two, four, twelve, twenty-four and one hundred and forty-four unequal parts; *second*, into two, four, six, eight, twelve, twenty-four, forty-eight, sixty, ninety-six and into one hundred equal parts, without including the small sub-divisions of minutes and seconds. The common practice at present with most civilized nations is to divide the day into two series of twelve hours each, a custom which corresponds very closely with that followed by the ancient Egyptians long before the Christian era. Thus, while we have made extraordinary advances in all the arts and sciences, and in their application to everyday life, we find ourselves clinging to a conventional and inconvenient mode of computing time; one not materially different from that practised by the Egyptians perhaps thirty centuries ago—a custom which answered every purpose when the world was young and its inhabited portion of narrow limit, but now indefensible in theory and inconvenient in practice.

The Chinese system would, without a doubt, suit the requirements of this age much better than that which we now follow. The halving of the day is one source of difficulty which ought not to exist, and it would be an important step to imitate the custom of computing time which is followed by that old oriental civilization. The adoption of the Chinese system, by which half days would be thrown out of use, would not, however, obviate the other very serious objections which have been raised. To overcome at once all the difficulties is the problem which presents itself for solution.

A SCHEME OF UNIFORM TIME-RECKONING.

It has been stated that the period occupied by a diurnal revolution of the earth, is the shortest measure of time which we find in nature. As a consequence, man is left to reckon and sub-divide this measure in the way best calculated to promote his own convenience. There can be no doubt whatever that all smaller divisions, except that produced by the rising and setting of the sun, must be artificial and arbitrary.

When the decimal system was adopted by the French, it was proposed to divide the day into ten and a hundred parts; a scheme which would probably be the best at this age of the world, had the whole system of horology to be established *de novo*. In view of generally prevailing customs, however, it will doubtless be felt that any attempt to introduce the decimal division of the day would be unwise; that it would be futile to propose a change which could only succeed by seriously interfering with the present notations.

The progress of the world may indeed before long demand a radical change in our chronometry; but the present method of computing time in the more civilized parts of the earth is so interwoven with every day life, that it cannot in the meantime be disregarded. It will be evident that the consideration of any change should be based on the full recognition of established customs. Instead of attempting to uproot and supersede the present system, it is considered that any new scheme to meet the requirements of the age should rather be engrafted on and be in as complete harmony as possible with the old one.

In this view the following suggestions are offered:

Our first effort should be to find a suitable unit measure of time, uniform in length, and, for obvious reasons, the shortest to be found in nature.

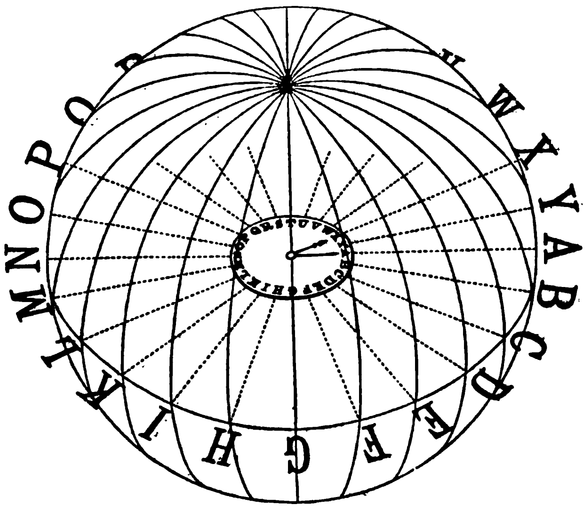
The sidereal day fulfils these conditions, and therefore suggests itself as being suited for the standard required.

The sidereal day is not, however, sufficiently marked for the ordinary purposes of life. The generality of mankind could not easily note the culmination of a star. On the other hand, the diurnal return of the sun in the heavens is a more striking and easier observed phenomenon. Accordingly, there is everything to suggest the adoption for the unit measure, not the solar day on account of its variable length, but the mean period occupied by a revolution of the earth on its axis, in relation to the sun.

That period would be precisely equal in length to the artificial day, known as the mean solar day. The unit measure proposed should not, however, be considered in the light of an ordinary day, but rather as a known period of abstract time—"day" being the name given to denote certain local phenomena successively and continuously occurring at the earth's surface.

It is proposed to divide the unit measure into twenty-four equal parts, and these again into minutes and seconds, by a standard timekeeper or chronometer, hypothetically stationed at the centre of the globe.

Fig. 1.



It is proposed that, in relation to the whole globe, the dial plate of the central chronometer shall be a fixture, as in Fig. 1; that each

of the twenty-four divisions into which the unit of time is divided, shall be assumed to correspond with certain known meridians of longitude, and that the machinery of the instrument shall be arranged and regulated so that the index or hour hand shall point in succession to each of the twenty-four divisions as it became noon at the corresponding meridian. In fact, the hour hand shall revolve from east to west with precisely the same speed as the earth on its axis, and shall therefore point directly and constantly towards the sun, while the earth moves round from west to east.

Each of the twenty-four parts into which the time-unit is proposed, as above, to be divided, would be exactly equal in length to an hour; but they ought not to be considered hours in the ordinary sense, but simply twenty-fourth parts of the mean time occupied in the diurnal revolution of the earth. Hours, as we usually refer to them, have a distinct relation to noon or to midnight at some particular place on the earth's surface, while the time indicated by the standard chronometer would have no special relation to any particular locality or longitude. It would be common and equally related to all places, and the twenty-four sub-divisions of the unit-measure would be simply portions of abstract time.

The standard time-keeper is referred to the centre of the earth, in order clearly to bring out the idea that it is equally related to every point on the surface of the globe. The standard might be stationed anywhere—at Yokohama, at Cairo, at St. Petersburg, at Greenwich, or at Washington. Indeed, the proposed system, if carried into force, would result in establishing many keepers of standard time, perhaps in every country, the electric telegraph affording the means of securing perfect synchronism all over the earth.

In order properly to distinguish the new unit measure and its sub-divisions from ordinary days and ordinary hours, a new nomenclature might be advisable. The employment of the letters of the alphabet for the twenty-four divisions would in most civilized countries completely distinguish them from local hours, and the twenty-four meridians, which on the surface of the globe would correspond with the sub-divisions, might also be so known. It would farther be expedient to distinguish the proposed new system from sidereal, astronomical, civil or local time. For this purpose either of the designations, "common," "universal," "non-local," "uniform," "absolute," "all world," "terrestrial," or "cosmopolitan," might be employed. For the present it may be convenient to use the latter term.

Besides the standard keepers of "cosmopolitan" time, established at many places possibly in every civilized country, it is suggested that every clock and watch should, as far as practicable, move synchronically, all indicating the same time.

As a theory, it is proposed that when the hands of any one timepiece point to *A* or to *G*, the hands of each and every other horological instrument in use throughout the globe should point to *A* or to *G* at the same moment.

It is proposed that, in establishing the zero of the sub-divisions and its corresponding meridian in relation to the surface of the earth, regard be had to the general convenience, and that the views and interests of all nations should, as far as practicable, be equally consulted.

Under the system of cosmopolitan time, the meridian which corresponds with zero would practically become the initial or prime meridian of the globe. The establishment of this meridian must necessarily be arbitrary. It affects all countries, more especially maritime countries, and in consequence of prejudice and national sentiment, it is possible that delicacy and tact and judgment may have to be exercised in the consideration of the subject. There ought not, however, to be much difficulty in dealing with the question. Matters of scientific concern are not and should not be made subservient to national jealousy. Science is cosmopolitan, and no question can be more thoroughly so than that which we are attempting to investigate.

In a separate paper, I have at some length discussed this branch of the subject, and I trust I have succeeded in pointing out a convenient and suitable position for a prime meridian, common to all the world, a selection which would offend no prejudice, and when carefully considered would, I feel assured, commend itself as well calculated to meet all the purposes for which a common initial meridian has for a great many years back been proposed, and likewise those special objects for which it is now suggested.

COSMOPOLITAN AND LOCAL TIME.

Assuming a common zero of longitude established by general concurrence, each rotation of the earth on its axis may be noted by all nations simultaneously. Under the system of cosmopolitan time, it would be everywhere practicable to keep an accurate chronological reckoning without complication or confusion. It is necessary, how-

ever, to consider the points in which all parts of the earth have equally an interest; and it is important to inquire how the scheme of reckoning proposed can be generally adapted to the ordinary requirements of life.

The diurnal return of the prime meridian to a point in the heavens opposite the sun, would mark the common unit-measure of time throughout the world. Its beginning and ending, its twenty-four divisions and its sub-divisions, would each in turn prevail everywhere at the same moment of absolute time. This common measure would, however, completely coincide with the local day of only one meridian. The local days of countless other longitudes would have as little coincidence with the unit-measure as with each other. At the same moment they would all differ; while it would be noon with one, it would be midnight with another, sunrise with a third; and so on.

Men and nations may agree to establish for convenience a common unit-measure of time; but dawn and dusk, light and darkness, will sweep round the globe, following each other in silent yet certain succession, as long as the world lasts—phenomena to prescribe in every land when men shall sleep, and when return to active life. The position of the sun in every local sky will always control domestic usages and continue to govern social customs. Do what we may, the ever changing local day, as it continully progresses from longitude to longitude, will everywhere assert itself and exact recognition.

How then are we to derive any practical good from the advantages which, as a theory, the system of cosmopolitan time appears to promise?

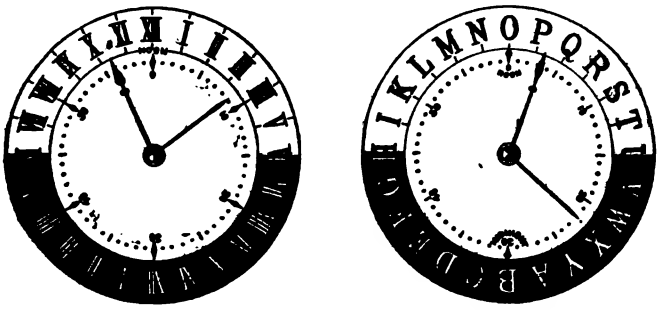
(1) All old customs may be retained for local purposes as at present, the new system being introduced as the means of more accurately reckoning time in connection with telegraphs and steam communication by land and water, and in describing events in which all mankind have a common interest.

(2) On the other hand, the new system may to some extent supersede present customs, and be employed for reckoning local as well as general time.

(3) A compromise may be suggested by which we would have cosmopolitan time as a common measure for reckoning dates and periods of general interest, and a number of sub-standards, each equally related to the common standard, for distinct local time.

It is obvious that to retain the old custom of reckoning hours, and at the same time secure the advantages of the cosmopolitan or non-local system, dual time-keepers, but not necessarily two distinct sets of time-keepers, would be required. This object is attained by having two dials to the one time-keeper, placed, in the case of a watch, back to back, or in the case of a stationary clock, side by side, as in Fig. 2;

FIG. 2.



LOCAL TIME. COSMOPOLITAN TIME.

the instruments being constructed so that the same wheel-work would move the hands of both dials. The figure No. 2 is suggested for a stationary clock; the night half of the dials are shaded.

The dial with the Roman numerals is designed for local time, while the lettered dial is for cosmopolitan or non-local time, to be used in connection with railways, steamboats and telegraphs, and as a record of passing historical events.

It is obvious that if clocks and watches were constructed on these principles, the difficulties and inconveniences which have been alluded to, and which seem inseparable from the present system, would be fully met. Assuming the scheme to be in general use: while local time would be employed for all domestic and ordinary purposes, cosmopolitan time would be used for all purposes not local; every telegraph, every steam line, indeed every communication on the face of the earth, would be worked by the same standard. Every traveller having a good watch, would carry with him the precise time that he would find observed elsewhere. *Post meridian* could never be mistaken for *ante meridian*. Railway and steamboat time-tables would be simplified and rendered intelligible, and no one can claim that such now is the rule.

As an illustration, I present condensed time-tables of the great railway route now being established from London to the Pacific through Canada. Table A is prepared in accordance with the present system. Tables B and C are two different modes of applying the system of cosmopolitan time, and illustrate the simplicity of that system for such purposes. (*Vide* Appendix, No. 1.)

It has been said that the 24 sub-divisions of the unit-measure may be known by letters, in order to be distinguished from local hours. But why use numerals for local hours? Numerals have no special advantage over letters; habit has undoubtedly rendered the former familiar to the mind of this generation in connection with the hour of the day; but if the 24 divisions had to be again named, and letters instead of numerals were adopted, the time of day could be as well expressed and as easily comprehended as at present. On the other hand, letters when arranged in a circle, as on the dial of a clock, have at least this advantage over numerals: they are all symbols of equal importance, and any one letter could be taken to represent the beginning of the series of the 24 which make up the day; while in the case of numerals, the lowest number can only represent the first of the series.

Let us take an illustration of the advantages of letters in connection with the scheme. Suppose *G* to be the noon letter at a particular place, how easy it would be for a resident to comprehend that it was always noon when the hour hands of the clock pointed to *G*; that it was always midnight when they pointed to *T*, the letter on the dial plate opposite to *G*; or, in speaking of any particular time of day, say four hours before mid-day, it would be as easy to comprehend the time referred to by the use of the letter *C* as by the numeral 8. Persons living in that locality would soon become familiar with the relation which the several letters had to the time of day.

Again, if we pass to a locality where another letter *O* becomes the meridian or noon letter, there could be no misunderstanding the meaning of the expression, *Time P. 22.* It could have but one meaning, viz., 1 hour and 22 minutes after mid-day, while 1.22 has a double meaning, undetermined without the addition of "*ante meridian*" or "*post meridian.*"

Thus it may be shown, if we could entirely ignore old practices and begin *de novo*, the nomenclature proposed for cosmopolitan time might very readily be employed for local purposes.

To render the dial plates of time-pieces perfectly intelligible in each place when used for local time, the expedient shown in Fig. 3 might be adopted.

FIG. 3.

LOCAL AND COSMOPOLITAN TIME.

Here the noon and midnight letters are easily distinguished, and that portion of the day which includes the hours of darkness cannot be mistaken. These or similar expedients could be employed with the same effect in the clocks and watches used in every place on the surface of the earth.

It would, however, be vain to assume that the present system could be at once abolished and disregarded. It becomes expedient, therefore, to consider how the advantages of the scheme of cosmopolitan time could be secured in everyday life. It is perfectly obvious that the present system cannot be overlooked; and that, although it may not be always maintained, it must for some time be continued. We must therefore look for some means by which the new notation may be employed in conjunction with the old, until the latter would fall into disuse.

It may be said that local time is almost always more or less arbitrarily established. Our clocks but rarely indicate true local time, and the most perfect time-pieces are for the greater portion of the year either faster or slower than the sun. In fact, correct ordinary time-keepers must necessarily at certain seasons be about 15 minutes faster or slower than true solar time, and no inconvenience whatever is found to result. The adoption of Irish time in England, or English time in Ireland, could not be felt in civil affairs. The difference between English and Irish time, as arbitrarily established, is twenty-five minutes; but in the west of Ireland local mean time is forty minutes, and solar time sometimes fifty-five minutes behind English time (Greenwich). Greenwich time is used

throughout England and Scotland, although it is half an hour faster than local mean time, and sometimes forty-five minutes faster than solar time on the west coast of the latter country.

In every country, local time is more or less arbitrarily established; it could not be otherwise, without causing great confusion, as no two places, unless in the same meridian, have the same true local time. In considering the whole subject, it is felt that if some simple rule could be agreed upon for defining local time everywhere, it would materially add to general convenience.

It is suggested that each of the twenty-four lettered meridians (Fig. 1) should be taken as standards for establishing approximate local time, and that as a general rule all places should adopt the local time of the nearest of these meridians. This would divide the surface of the globe into twenty-four "lunes," forming distinct local sections. Although the twenty-four fixed meridians would be at one hour's distance from each other, only in extreme cases would the difference between the true and approximate local time be as much as half an hour. In many cases there would be no difference, and in no case could the difference be of the slightest moment in the ordinary business of civil life. Whenever exact time was required for any purpose, cosmopolitan time, assuming it to be in general use, would be available, or a third hand, such as shown by the dotted line in the figure, might in certain cases be used.

Fig. 4.

Cosmopolitan Watch Dial.

Fig. No. 4 represents a compound dial designed to indicate non-local as well as local time, on the same face of a clock or watch, by means of one set of hands. In this arrangement it is proposed to have the Roman numerals for local time inscribed on a movable disc,

adjustable for each separate hour, and may thus be set for any one of the twenty-four fixed meridians referred to. The adjustment would be effected without in the least disturbing the machinery of the instrument, or interfering with the index hands.

Church clocks and other stationary time-pieces would have the local time disc permanently secured in the proper position. Only in the case of persons travelling beyond any particular local time section would the local time disc of their watch require to be changed. Its adjustment under such circumstances would be simple; it would only be necessary to move the disc round until 12 o'clock noon coincided with the meridional letter of the new locality. Suppose, for example, the letter *G* represented the longitude of the new position of the watch: 12 noon placed in conjunction with *G* would complete the adjustment of the instrument. For every other new position the same operation would be repeated. Notwithstanding every change that may be made for local time, the machinery of the watch need not be interfered with, and the hands would continue to indicate correct cosmopolitan time. The distinction between cosmopolitan time and local time would always be perfect; the former would invariably be known by letters; the latter, as at present, by the Roman numerals.

As in the diagrams, it is proposed to denote that portion of the day which includes the hours of darkness by a black or dark ground, in order that the night hours could never be mistaken for the hours in the middle of the day, which have the same numerals. The several "watches" into which the day is divided on shipboard might be distinguished. The local time disc exhibits a light portion between 8 a.m. and 4 p.m.; this includes and represents the forenoon and afternoon watches, noon being the dividing point. The dark portion, extending four hours before and four hours after midnight, embraces the two night watches; while the shaded portions, from 4 p.m. to 8 p.m., and from 4 a.m. to 8 a.m., represent the dog watches and the morning watch. This arrangement would perhaps prove useful, in view of the hundreds of thousands who navigate the ocean, and the yearly increasing number of ships that adopt and constantly use this division of the day into "watches," finding it, as they appear to do, the most convenient scheme of division for daily routine at sea.

Other modes of carrying into execution the principles of construction proposed will readily suggest themselves to practical men. (*Vide* Appendix No. 2.) It seems only here necessary to allude to one point. It may be objected that the change of system would render

the clocks and watches in use valueless. But the remedy is simple, as local time may be retained and indicated side by side with cosmopolitan time by altering the dial plates or substituting new ones.

The establishment of twenty-four fixed meridians, as proposed, at one hour's distance from each other, as standards for local time, would secure complete uniformity in the indication of the minutes in all the clocks of the world; the hours of local time only differing. Appendix No. 3 illustrates this feature; it shows simultaneous time at each of the twenty-four standard meridians; local time varying one hour in each case; cosmopolitan time remaining constant.

In this communication I have endeavoured to submit the inconveniences and difficulties inseparable from our present mode of reckoning dates, and from our system of keeping and noting smaller divisions of time. I have referred to the various usages and customs which prevail, and I have drawn special attention to the fact that the application of steam to locomotion by land and sea, and of electricity to the telegraph, literally without limit, has rendered the present practice of reckoning time ill suited to modern life.

It cannot be supposed that these agents of progress have completed their mission. We may rather assume that these extraordinary powers have but commenced their wonderful career, and that they will achieve further triumphs in civilization.

It is in America these agents have been introduced to the greatest relative extent, as the subjoined estimate of the length of railways constructed will show:

	Population.	Miles of Railway.
Asia	824,548,500	7,643
Europe	309,178,300	88,748
Africa	199,921,600	1,451
N. and S. America	85,519,800	83,655
Australasia	4,748,600	1,752
Totals	1,423,917,800	183,248

It has been suggested, that the difficulties already met in portions of America threaten to become increased as the railway system is extended. It may therefore be assumed, that any practicable scheme to effect a remedy would be favourably received. The importance of the subject is not confined to America, for the other quarters of the globe are now or will be similarly interested. Australia and Africa will before long be pierced, perhaps girdled, by railways. Asia, with more than half the population of the world, must in due time follow in the general progress. In North and South America, there is room

for a great increase of railways; but taking the present mileage and population of that continent as a basis, the proportion would give to Europe and Asia together more than one million miles of lines. These two great continents have as yet only 96,000 miles of railway, and it would probably be taking too sanguine a view to suppose that so great an increase will speedily be realized. No one, however, can doubt that the network of railways in Western and Central Europe will before long be greatly enlarged; that branches will extend to Asia; and that off-shoots will ultimately be prolonged to the farthest shores of the Chinese and Russian Empires. A comparatively few years may indeed witness extraordinary progress in this direction, to bring into prominence the difficulties alluded to, and which cannot fail to make themselves felt.

The subject which we are now considering, in different degrees clearly concerns all countries; it is especially important to the United States, Brazil, Canada, indeed to the whole of America. It is important to France, Germany, Austria, and to every nation in Europe. It is of peculiar interest to the gigantic empire of Russia, extending over nearly 180 degrees of longitude, and with a total variation in local time of about twelve hours. It is of still greater importance to the Colonial Empire of Great Britain, with its settlements and stations in nearly every meridian around the entire globe, and with vast territories to be occupied in both hemispheres.

Before the introduction of railways in England, every town and village kept its own time. The traveller found his watch constantly at variance with the local clocks. On the establishment of the railway system this state of things could not be tolerated, as local time could only lead to complication and confusion. The railways demanded uniform time, and Greenwich time came to be used. This was looked upon as an innovation, and was for a considerable period vigorously opposed. At last the advantages of uniform time became so manifest, that Greenwich time came into general use throughout Great Britain.

But for the employment of uniform time in England, Scotland and Ireland, it would be an extremely difficult task to regulate safely the great number of daily trains. The safe working of the railways in the United Kingdom is indeed a problem sufficiently difficult even with uniform time; and we can scarcely conceive how much the problem would be complicated if in Great Britain they were to revert to the system of local time as it prevailed in the days of stage coaches, when every town and hamlet kept its own time.

Among the several objects which the scheme of cosmopolitan time has in view, not the least important is to extend to the world similar advantages to those which have been conferred on Great Britain by the general adoption of uniform time since the commencement of the railway era.

Meteorologists have felt the necessity of some general scheme of reckoning by non-local time, such as that now proposed. The enormous number of meteorological observations recorded in every part of the world are of but little value until accurate allowances are made for the differences in local time. The immense labour involved will be understood when the number of stations and the number of daily and hourly observations are considered. Accordingly, it will be seen that meteorological science would derive great advantages from the general adoption of uniform time.

Navigators are required to employ a standard time to enable them from day to day, when on long voyages, to compute their longitude. For this purpose it is a practice with ships to carry the local time of the national observatory of the country to which they respectively belong. For example: French ships reckon their longitude by Paris time; British ships by Greenwich time. Cosmopolitan time would serve precisely the same purpose as a standard for geographical reckoning, and it would be some advantage to the marine of the world to have a uniform standard established—the common property of all nations, and in common use by land and water everywhere. It has already been said that the telegraph provides the means of securing perfect accuracy at all stations, however remote; indeed, through this agency, time-keepers may be made to beat time synchronously all over the globe. Already the length of telegraph lines in operation approaches 400,000 miles; and we are warranted in believing that ultimately the means of instantaneous communication will ramify through every habitable country, and find its way to every port of commercial importance.

I take the ground that we have entered upon a remarkable period in the history of the human race. Discoveries and inventions continue to crowd upon each other in almost magical succession, and who can tell what progress will be made within the coming fifty years? Steam and electricity are really narrowing the limits of the world. Lines of telegraph and steam communications, the creations of but yesterday, are girdling the earth and bringing the most distant countries into close neighbourhood. In a few years the wire and the

rail will have brought men of all races face to face to intercommunicate knowledge and dispel prejudices. Sooner or later the barbarous custom of dividing the day into two sets of twelve hours, as if 12 was the limit of arithmetical knowledge, will be judged at its right value. The hands of time-keepers pointing in all conceivable directions at the same instant of absolute time will be held as an extraordinary anomaly, and steps will be taken to avoid the spectacle of men at the one moment nominally living in different hours, in different days, and in some extreme cases in different months and years.

The system of chronometry which we have inherited may have been well suited to the purpose for which it was designed long centuries ago, when the known world was confined within the pillars of Hercules, or it may even have answered all the requirements of man a few generations back, before the great modern civilizers, steam and electricity, began their work. Now we realize the fact that the system is awkward and inconvenient. In a few years—and who can count them—may we not find a radical change imperatively demanded by the new conditions of the human race.

It is probably not now unseasonable to discuss the subject. It would be a vain task to attempt at once to abolish a custom so hoary with age, and so generally practised as our system of computing time. But the necessity of change once admitted, the public mind will gradually become familiar with the idea, and will learn to welcome any modification in the system when its expediency is established.

But it will be important first to determine the extent of the required modification. The scheme should be well considered so as to be free from the imperfections which result from haste. It should be rendered generally acceptable, so that whenever the necessity arises in any country or community for its introduction, it may be spontaneously adopted; the inhabitants feeling assured that they were selecting a system eventually to become universal.

The suggestions I have ventured to offer are presented with the view of drawing attention to the subject. They point to the establishment of a common prime meridian as the first important step, and as the key to any cosmopolitan scheme of reckoning. This step taken, the more progressive nations would probably promote the establishment of a comprehensive system of chronometry suitable to every condition of civilization, and advantageous to the inhabitants of the globe on every line of longitude and on every parallel of latitude.

APPENDIX No. 1.

Condensed time-tables, illustrative of the application of the cosmopolitan system of time-reckoning, to railway and steamboat communications. The great mail and passenger route now being established through Canada is selected as an example. Table A is arranged according to the present system. Table B is arranged for cosmopolitan time. Table C is arranged for local time standards, established by lettered meridians 15° of longitude apart, each varying one hour. The hours of the day are numbered from 1 to 24 instead of two sets from 1 to 12.

TABLE A.—*Arranged according to the present system.*

Principal Stations.	Local Time.		Slower than Greenwich.
London	8.00 p.m.	Greenwich time	0.00
Dublin	8.00 a.m.	Irish time	0.25
(*en route*)	.. 1st noon	Irish time	"
W. Coast Ireland	1.00 p.m.	Irish time	"
(*at sea*)	.. 2nd noon	Ship's time	1.00
(*at sea*)	.. 3rd noon	Ship's time	1.40
(*at sea*)	.. 4th noon	Ship's time	2.20
(*at sea*)	.. 5th noon	Ship's time	3.00
St. John, Newfoundland	9.00 a.m.	Newfoundland time	3.30
(*en route*)	.. 6th noon	Newfoundland time	"
St. George, Newfoundland	6.00 p.m.	Newfoundland time	"
Shippigan	10.00 a.m.	New Brunswick	4.30
(*en route*)	.. 7th noon	New Brunswick	"
Riv. du Loup	10.00 p.m.	Quebec time	5.00
Quebec	2.00 a.m.	Quebec time	"
Montreal	8.00 a.m.	Quebec time	"
(*en route*)	.. 8th noon	Quebec time	"
Ottawa	1.00 p.m.	Quebec time	"
Nippising	8.30 p.m.	Huron time	5.30
L. Superior	10.00 a.m.	Superior time	6.00
(*en route*)	.. 9th noon	Superior time	"
Fort William	3.30 p.m.	Superior time	"
Keewatin	1.30 a.m.	Manitobah time	6.30
Selkirk	6.00 a.m.	Mantiobah time	"
(*en route*)	.. 10th noon	Mantiobah time	"
Livingston	3.00 p.m,	Saskatchewan time.	7.00
Saskatchewan	9.30 p.m.	Saskatchewan time.	"
Battleford	1.00 a.m.	Athabasca time	7.30
Edmonton	9.20 a.m.	Athabasca time	"
(*en route*)	.. 11th noon	Athabasca time	"
Montbrun	2.15 p.m.	Athabasca time	"
Yellow Head Pass	7.00 p.m.	Rocky Mount'n time	8.00
Tete Jaune Cache	8.15 p.m.	Rocky Mount'n time	"
(*en route*)	.. 12th noon	Rocky Mount'n time	"
Pacific Ocean	11.30 p.m.	B. Columbia time	8.30

TABLE B.

Arranged for Cosmopolitan Time.

Principal Stations.	Cosmo-politan Time.
London	P. 00
Dublin	C. 25
1st *Noon* (*en route*)....	G. 25
W. Coast Ireland	H. 25
2nd *Noon* (*at sea*)	H. 00
3rd *Noon* (*at sea*)	H. 40
4th *Noon* (*at sea*)	I. 20
5th *Noon* (*at sea*)	K. 00
St. John, Newfoundland .	G. 30
6th *Noon* (*en route*) ..	K. 39
St. George, Newfoundland	R. 00
Shippigan	I. 30
7th *Noon* (*en route*) ..	L. 30
Riv. du Loup	W. 00
Quebec	B. 00
Montreal	H. 00
8th *Noon* (*en route*) ..	M. 00
Ottawa	N. 00
Nippising	V. 00
L. Superior	L. 00
9th *Noon* (*en route*) ..	N. 00
Fort William	Q. 30
Keewatin	C. 00
Selkirk	G. 30
10th *Noon* (*en route*) ..	O. 00
Livingston	R. 00
Saskatchewan	X. 30
Battleford	C. 30
Edmonton	M. 00
11th *Noon* (*en route*) ..	P. 00
Montbrun	Q. 45
Yellow Head Pass	W. 00
Tete Jaune Cache	X. 15
12th *Noon* (*en route*) ..	P. 30
Pacific Ocean	W. 30

TABLE C.

Local Time Standards, established one hour apart.

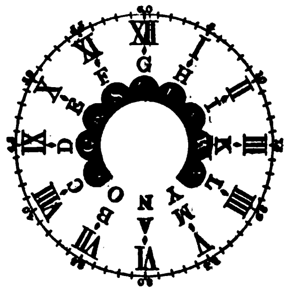
Principal Stations.	Local Time.	
	Hours.	By Standard.
London	20.00	M.
Dublin	8.25	"
1st *Noon* (*en route*).	12.00	"
W. Coast Ireland ..	13.25	"
2nd *Noon* (*at sea*)..	12.00	N.
3rd *Noon* (*at sea*)..	12.00	O.
4th *Noon* (*at sea*)..	12.00	O.
5th *Noon* (*at sea*)..	12.00	P.
St. John, Newf'dland.	8.30	Q.
6th *Noon* (*en route*)	12.00	"
St. George, Newf'dland	17.30	"
Shippigan	9.30	R.
7th *Noon* (*en route*)	12.00	"
Riv. du Loup	22.00	"
Quebec	2.00	"
Montreal	8.00	"
8th *Noon* (*en route*)	12.00	"
Ottawa	13.00	"
Nippising	20.30	"
L. Superior..........	10.00	S.
9th *Noon* (*en route*)	12.00	"
Fort William	15.30	"
Keewatin	1.00	T.
Selkirk	5.30	"
10th *Noon* (*en route*)	12.00	"
Livingston	15.00	"
Saskatchewan	21.30	"
Battleford	1.30	"
Edmonton	10.00	"
11th *Noon* (*en route*)	12.00	V.
Montbrun	13.45	"
Yellow Head Pass ..	19.00	"
Tete Jaune Cache	20.15	"
12th *Noon* (*en route*)	12.00	"
Pacific Ocean	11.00	"

APPENDIX No. 2.

The application of the proposed Scheme of Time-reckoning to the practice of Daily Life.

Reference has been made to the means by which cosmopolitan time may be indicated by ordinary time-pieces. This may be accomplished by inscribing the proper letters on the dials of clocks and watches now in use. A still better expedient would be to substitute new dials, such as Fig. 5. In this, the letters which represent the night hours in any particular locality are on a dark ground.

Fig. 5.



By a simple expedient of this description it could be practicable, without superceding the old time-keepers, to secure the advantages of the new scheme, in any country of comparatively limited extent.

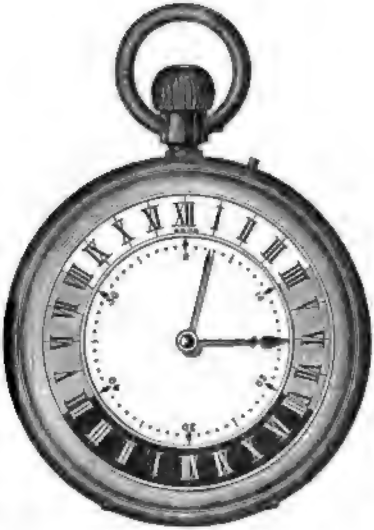
Clocks and watches in use might thus be utilized and made to show cosmopolitan, in addition to local time. It would be only necessary to prepare railway and steam-boat time-tables in accordance with the new system, to bring its advantages into common use. But this would apply only to stationary clocks, or to watches in use in countries limited in extent. The improvement would not be general until time-keepers for ordinary purposes, and especially watches, were constructed on new principles. A general change could only be gradually effected; but as there are hundreds of thousands of watches and chronometers made every year, in the event of the subject being deemed worthy of attention, it would be well for manufacturers to consider the expediency of introducing some change in the construction of them.

There are various methods by which the principles set forth may be applied, and these will readily suggest themselves to prac-

tical men. Simply to illustrate one mode, Figures 6 and 7 are supplied.

Fig. 6.

Fig. 7.



The object is to indicate cosmopolitan and local time by the same watch. Fig. 6 shows the watch case open, with the dial for cosmopolitan time exposed. Fig. 7 shows the watch case closed, with the local time numerals engraved on the face of the case, the latter being pierced in order that the hands may be seen. The local time disc is designed to be adjustable for any one of the 24 lettered meridians. By this arrangement only the local hours would vary; there would be a complete coincidence in the minutes of cosmopolitan and local time at every station. The application of double dials to a watch may be effected in another manner. The watch may have two faces back to back; one for for cosmopolitan time, the reverse for local time, the hands in both instances being moved by the same wheel-work, and those for local time supplied with the means of adjustment for change of longitude.

The latter plan has advantages peculiar to itself. Other methods of construction may be proposed, but it is unnecessary; the present object is simply to show that there is no practical difficulty in the way of carrying the scheme of time reckoning set forth in the accompanying paper into the practice of daily life.

APPENDIX No. 3.

Illustrating Simultaneous Time at each of the twenty-four lettered meridians proposed as Local Standards; Local Time differing one hour in each case; Cosmopolitan Time remaining constant.

MERIDIAN A.

Local time................. 6.45 p.m.

Cosmopolitan time .... G. 45

Longitude (proposed new reckoning)............ 15°

Longitude, old style ...... 165° East.

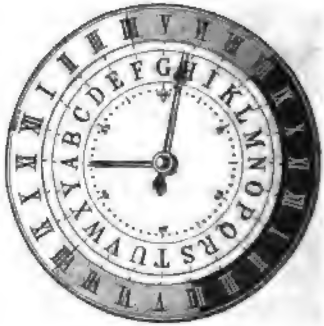
MERIDIAN B.

Local time .... 5.45 p.m.

Cosmopolitan time.......... G. 45

Longitude .... 30°

Longitude, old style .... 150° East.



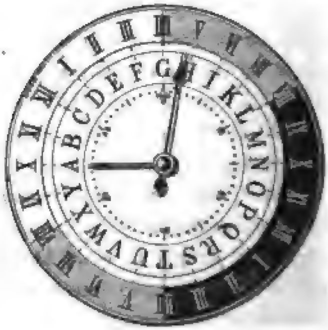
MERIDIAN C.

Local time .... 4.45 p.m.

Cosmopolitan time.......... G. 45

Longitude .... 45°

Longitude, old style .... 135° East.



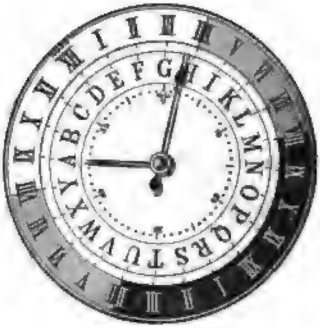
MERIDIAN D.

Local time .... 3.45 p.m.

Cosmopolitan time.......... G. 45

Longitude .... 60°

Longitude, old style .... 120° East.



MERIDIAN E.

Local time .... 2.45 p.m.

Cosmopolitan time.......... G. 45

Longitude .... 75°

Longitude, old style .... 105° East.

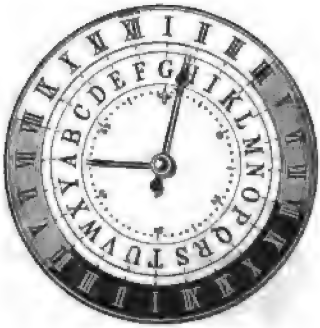
MERIDIAN F.

Local time .... 1.45 p.m.

Cosmopolitan time.......... G. 45

Longitude .... 90°

Longitude, old style .... 90° East.



MERIDIAN G.

Local time .... 12.45 p.m.

Cosmopolitan time.......... G. 45

Longitude .... 105°

Longitude, old style .... 75° East.

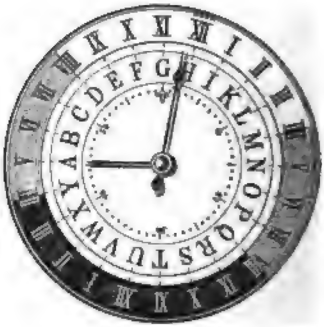
MERIDIAN H.

Local time .... 11.45 a.m.

Cosmopolitan time.......... G. 45

Longitude .... 120°

Longitude, old style .... 60° East.



MERIDIAN I.

Local time .... 10.45 a.m.

Cosmopolitan time.......... G. 45

Longitude .... 135°

Longitude, old style .... 45° East.

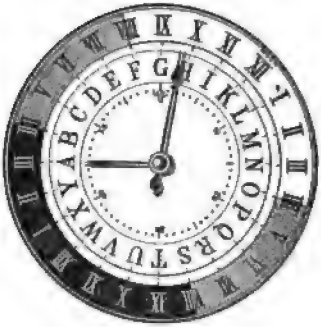
MERIDIAN K.

Local time.................. 9.45 a.m.

Cosmopolitan time .... G. 45

Longitude .... 150°

Longitude, old style .... 30° East.



MERIDIAN L.

Local time.................. 8.45 a.m.

Cosmopolitan time .... G. 45

Longitude .... 165°

Longitude, old style .... 15° East.

MERIDIAN M.

Local time.................. 7.45 a.m.

Cosmopolitan time .... G. 45

Longitude .... 180°

Longitude, old style...... 0° Greenwich

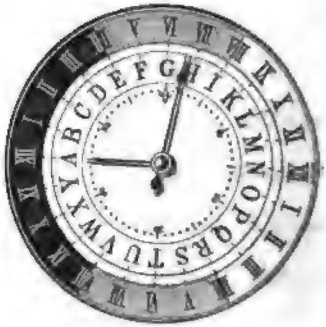
MERIDIAN N.

Local time .... 6.45 a.m.

Cosmopolitan time.......... G. 45

Longitude .... 195°

Longitude, old style .... 15° West.



MERIDIAN O.

Local time .... 5.45 a.m.

Cosmopolitan time.......... G. 45

Longitude .... 210°

Longitude, old style .... 30° West.

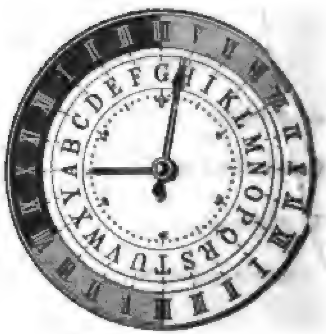
MERIDIAN P.

Local time .... 4.45 a.m.

Cosmopolitan time.......... G. 45

Longitude .... 225°

Longitude, old style .... 45° West.



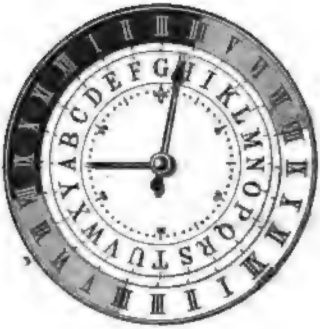
MERIDIAN Q.

Local time .... 3.45 a.m.

Cosmopolitan time.......... G. 45

Longitude .... 240°

Longitude, old style .... 60° West.



MERIDIAN R.

Local time .... 2.45 a.m.

Cosmopolitan time.......... G. 45

Longitude .... 255°

Longitude, old style .... 75° West.

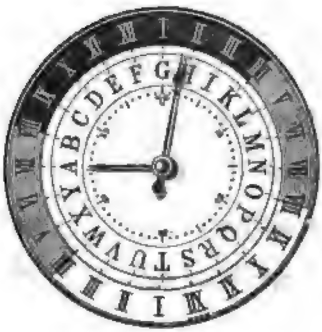
MERIDIAN S.

Local time .... 1.45 a.m.

Cosmopolitan time.......... G. 45

Longitude .... 270°

Longitude, old style .... 90° West.



MERIDIAN T.

Local time................ 12.45 a.m.

Cosmopolitan time .... G. 45

Longitude .... 285°

Longitude, old style........ 105° West.

MERIDIAN U.

Local time................ 11.45 p.m.

Cosmopolitan time .... G. 45

Longitude .... 300°

Longitude, old style........ 120° West.

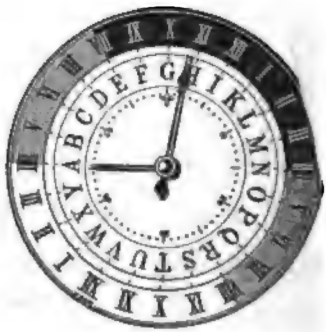
MERIDIAN V.

Local time................ 10.45 p.m.

Cosmopolitan time .... G. 45

Longitude .... 315°

Longitude, old style........ 135° West.



MERIDIAN W.

Local time................ 9.45 p.m.

Cosmopolitan time .... G. 45

Longitude .... 330°

Longitude, old style ...... 150° West.

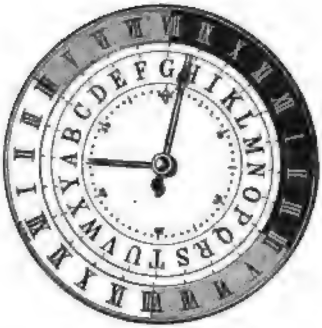
MERIDIAN X.

Local time................ 8.45 p.m.

Cosmopolitan time .... G. 45

Longitude .... 345°

Longitude, old style ...... 165° West.



THE PRIME MERIDIAN.

Local time.................. 7.45 p.m.

Cosmopolitan time .... G 45.

The Common Zero of Longitude 0°

Longitude, old style, 180° East & West.

LONGITUDE AND TIME-RECKONING.

A FEW WORDS ON THE SELECTION OF A PRIME MERIDIAN TO BE COMMON TO ALL NATIONS, IN CONNECTION WITH TIME-RECKONING.

BY SANDFORD FLEMING, C.M.G., ETC.

In another paper which I have submitted to the Institute, it has been stated that the only means of obviating the confusion inseparable from the present system of reckoning dates, is to measure time by the absolute diurnal revolutions of the earth.

By the system now followed, we count days by the consecutive passage of the sun over the meridian of each spot on the earth's surface. The number of spots around the globe may be said to be infinite, and accordingly the duration of the day, as it is locally distinguished, considered in relation to absolute time, is marked by an equally infinite variety.

It has been argued that the earth should be considered as a whole, and that its mean diurnal revolution should be the unit measure for reckoning dates; and this theory points to the consideration of the necessity of establishing a common prime meridian.

If we were placed in some neutral position, such as the earth's centre, or its poles, and were called upon to determine the time occupied by a diurnal revolution, we could fix on a point arbitrarily chosen in a circle inscribing the earth's axis, and note the time between two consecutive passages of the sun over that point. A plane passing through that point and the poles, extended to the surface of the globe, would establish a first or prime meridian from which longitude may be reckoned.

The establishment of an initial or prime meridian as the recognized starting point of time-reckoning by all nations, affects the whole area of civilization, and conflicting opinions may arise concerning its position. Its consideration must therefore be approached in a broad, cosmopolitan spirit, so as to avoid offence to national feeling and prejudice.

As far as practicable, the interests of all nations should be consulted in its choice, and the principle should be recognized, that the first meridian should be determined in accordance with the views of the greatest possible number.

Although the general acceptance of a common meridian for reckoning longitude has long been desired, unanimity has in no way been attained.

The meridians passing through the following points are more or less in use at the present time, viz.: Cadiz, Christiania, Copenhagen, Ferro, Greenwich, Lisbon, Naples, Paris, Pulkova, Rio de Janeiro, Stockholm, and Washington.

Several other meridians have at different times been used, or proposed to be used, for the computation of longitude. Ptolemy, to whom we are indebted, along with Marinus, for introducing the terms 'longitude' and 'latitude,' drew the first meridian through the Insulæ Fortunatæ, or Canary Islands, as the western limit of the earth's boundaries of his time; the exact position is not known with certainty.

According to Malte Brun, Louis XIII. of France, in order to render the manner of expressing longitude in French geography uniform, ordered, by an express declaration, that the first meridian should be placed in the Isle of Ferro, the most western of the Canaries. Delisle, one of the first who endeavoured to give precision to geographical determinations, fixed the longitude of Paris 20 degrees east of that meridian. When, by more rigorous observations, it was known that the difference of longitude between Paris and the principal town of the Isle of Ferro was 20° 5′ 50″, it was necessary to advance the first meridian 5′ 50″ to the east of that point, so that it is now a circle of mere convention, which passes through no remarkable point.

Geographers at one time established the first meridian at the island of St. Nicholas, near Cape Verd; others at the isle of St. James. Gerard Mercator, who lived in the sixteenth century, selected the meridian passing through the Island del Corvo, one of the Azores, on account, it is said, of the magnetic needle pointing due north at that time. It was not then known that the needle itself was subject to variations. The Dutch placed their first meridian at the Peak of Teneriffe. The Spaniards have chosen Cadiz. The British formerly used Cape Lizard, but subsequently selected Greenwich Observatory, near London. The Russians, Pul-

kova, near St. Petersburg. Washington was adopted by the United States, and the charts of that country are still constructed with Washington as a first meridian, although Greenwich is now used for reckoning longitude by all sea-going ships carrying the United States flag. The Italians selected Naples; and ships of the empire of Brazil reckon in part from Rio de Janeiro.

An earnest desire has frequently been expressed for the determination of one prime meridian common to all nations, but all attempts for its establishment have failed. On all sides there has been an adherence, with more or less tenacity, to the arbitrary zeros adopted or suggested by the national navigators. Recommendations have however from time to time been made in the general interests of science, which is unconfined by national boundaries and unprejudiced by national vanity. Some astronomers have proposed Alexandria, from its being the place to which Ptolemy's observations and computations were reduced. The Great Pyramid has also been proposed as the point through which the world's prime meridian should be drawn; it has found an earnest advocate in Professor Piazzi Smyth, Astronomer Royal for Scotland.

Other astronomers have proposed that a meridian should be established from celestial phenomena, so that national sensitiveness shall in no way be hurt. Laplace recommended the adoption of a universal first meridian, upon which it was 12 o'clock when the sun entered the point of the vernal equinox in the year 1250, in which the apogee of the earth's orbit coincided with the solsticial point in Cancer. According to Maury, such a universal meridian would pass about 8 miles west of Cape Mesurada, on the coast of Africa.

This initial meridian was favoured by Herschel. It is certainly suggested by no local circumstances such as noon or midnight, or by the observatory or metropolis of any nation. Its determination is made solely by the motion of the sun among the stars, in which all the nations of the earth have a common interest. Herschel designated the time reckoned by this meridian "Equinoctial time." But this meridian possesses no one advantage not common to all other meridians, beyond being perfectly free from national relationships.

The initial meridian for the world should be chosen for other reasons than any of those which, as far as I know, have yet been advanced. In another place I have shown that it would be the separating line on the surface of the earth, between two consecutive

diurnal revolutions; that is to say, between one cosmopolitan date (or day) and another. It would be, therefore, inexpedient to have it passing through London or Washington, or Paris, or St. Petersburg, or indeed through the heart of any populous or even inhabited country. We must seek for a position free from this characteristic.

We should look for a meridian, if possible, to pass through no great extent of habitable land, so that hereafter the whole population of the world would follow a common time-reckoning; and simultaneous human events would be chronicled by concurrent dates. If we examine the terrestrial globe, we shall find that two, and only two, limited sections of the sphere present themselves with these qualifications.

A meridian may be drawn through the Atlantic Ocean, so as to pass Africa on the one side and South America on the other without touching any portion of either continent, avoiding all islands and all land except a portion of eastern Greenland.

The configuration of the continents will also admit of a meridian being similarly drawn in the opposite hemisphere so as to pass through Behring's Strait, and through the whole extent of the Pacific Ocean without touching dry land.

Either of these meridians would serve the desired purpose, but a meridian in close proximity to Behring's Strait suggests itself as the most eligible.

It must be admitted that the establishment of a common prime meridian should be so determined that, if at all practicable, one of the several systems of the divisions of longitude now employed might be maintained. It would be a still greater advantage if the new initial meridian could harmonize with the longitudinal divisions most in use in the navigation of the high seas.

If we refer to the map of the world, we find that the *anti* or *nether* meridians of some of the capitals of Europe pass at no great distance from Behring's Strait, and the addition or subtraction of 180° would, in any one case, be a ready means of harmonizing the proposed new zero with the old reckoning of longitude. Six of these places are at present employed as prime meridians, viz.:

1. Christiania.	4. Naples.
2. Copenhagen.	5. Paris.
3. Greenwich.	6. Stockholm.

The following table, prepared from the latest authorities within reach, gives an estimate of the number and tonnage of steamers and

sailing ships belonging to the several nations of the world; likewise the first meridians which they use in ascertaining their longitude:

Country.	Ships of all Sorts.		First Meridians Used.
	Number.	Tonnage.	
Great Britain and the British Colonies	20,938	8,696,532	Greenwich.
United States ..	6,935	2,739,348	Greenwich.
Norway	4,257	1,391,877	Christiania and Greenwich.
Italy	4,526	1,430,895	Naples and Greenwich.
Germany	3,380	1,142,640	Ferro, Greenwich and Paris.
France	3,625	1,118,145	Paris.
Spain	2,968	666,643	Cadiz.
Russia..........	1,976	577,282	Pulkova, Greenwich and Ferro.
Sweden	2,151	462,541	Stockholm, Greenwich and Paris.
Holland	1,385	476,193	Greenwich.
Greece..........	2,036	424,418	
Austria	740	363,622	Greenwich and Ferro.
Denmark	1,306	245,664	Copenhagen, Paris and Greenwich.
Portugal........	491	164,650	Lisbon.
Turkey	348	140,130	
Brazil, &c., S. America	507	194,091	Rio de Janeiro and Greenwich.
Belgium	50	38,631	Greenwich.
Japan, &c., Asia.	78	39,391	Greenwich.
	57,697	20,312,093	

Taking these returns as a basis, it is roughly estimated that the shipping of the world reckon their longitude from the meridian of the several points mentioned in the following proportions, viz.:

From	Ships of all Kinds.		Per Cent.	
	Number.	Tonnage.	Ships.	Tonnage.
Greenwich	37,663	14,600,972	65	72
Paris	5,914	1,735,083	10	8
Cadiz	2,468	666,602	5	3
Naples..................	2,263	715,448	4	4
Christiania..............	2,128	695,988	4	3
Ferro	1,497	567,682	2	3
Pulkova	987	298,641	1½	1½
Stockholm	717	154,180	1½	1
Lisbon.....	491	164,000	1	1
Copenhagen	435	81,888	1	½
Rio de Janeiro	253	97,040	½	½
Miscellaneous	2,881	534,569	4½	2½
	57,697	20,312,093	100	100

It thus appears that of the total commerce of the world which in a greater or less degree bases its system of navigation on eleven different first meridians for the reckoning of longitude, 65 per cent. of the number of ships, and 72 per cent. of the total tonnage, compute their longitude east and west of Greenwich.

The United States of America at one time used the meridian of Washington. But the importance of having a common zero of measurement has been felt to be so great, that practical effect has been given to the idea, on the part of the United States, by all sea-going ships of the Republic, giving up Washington, and adopting the meridian of Greenwich. Russia, Norway, Holland, Belgium and Japan have taken the same course, and Germany, Sweden, Austria and Denmark have partially done so.

It is accordingly clear that of the six places mentioned, the nether meridians of which are convenient to Behring's Strait, Greenwich takes the first position with respect to the number and tonnage of ships navigating by it. The six several places, as far as known, seem to stand in the following order, viz.:

	SHIPS.	TONNAGE.
Greenwich	37,663	14,600,972
Paris	5,914	1,735,083
Naples	2,263	715,448
Christiania	2,128	695,988
Stockholm	717	154,180
Copenhagen	435	81,888

The meridian drawn 180° east and west of Greenwich crosses a small angle of Kamtschatka, immediately on the western side of Behring's Strait; with this exception, it passes over no land between the Arctic and Antarctic circles. The foregoing shows clearly that it is, of all the meridians, the one which would best accommodate the greatest number and tonnage of the world's shipping. By the adoption of this as a common prime meridian, there would be no disarrangement in the charts, the nautical tables, or the descriptive nomenclature of nearly three-fourths of the ships navigating the high seas. The same lines of longitude would be traced on the maps, although differently notated. The necessity would simply arise of falling back on the familiar phrases of 'new style' and 'old style,' first applied in connection with chronological dates in England in

1752—the year when popular prejudice was met and the calendar reformed.

The following table will show all the change that would be callep for in notating the degrees of longitude. It will be observed that the table is limited to the twenty-four lettered meridians elsewhere alluded to:

Hour Meridian.	Longitude.	
	New Style.	Old Style.
Prime Meridian	Zero	180° E. & W. of Greenwich
A	15°	165° E. of Greenwich.
B	30°	150° E. "
C	45°	135° E. "
D	60°	120° E. "
E	75°	105° E. "
F	90°	90° E. "
G	105°	75° E. "
H	120°	60° E. "
I	135°	45° E. "
K	150°	30° E. "
L	165°	15° E. "
M	180°	0° Greenwich
N	195°	15° W. of Greenwich.
O	210°	30° W. "
P	225°	45° W. "
Q	240°	60° W. "
R	255°	75° W. "
S	270°	90° W. "
T	285°	105° W. "
U	300°	120° W. "
V	315°	135° W. "
W	330°	150° W. "
X	345°	165° W. "
Prime Meridian	360 or Zero	180° W. "

But a proposal of this character cannot be effected without much discussion. Such a change must be the work of time, for it is to be feared that much passive if not active opposition would have to be overcome before general concurrence be obtained. Whatever benefits a measure may promise, there will always be those who fail to recognize the anticipated advantages; and there are generally not a few who consider it a duty to combat the least innovation on existing practices. The object of these remarks, however, is to show that there is no impediment to the establishment of a prime meridian for the world unmarked by national pre-eminence, a meridian in itself admirably adapted for the important purposes referred to in connection

with the notation of time, and the accurate reckoning of chronological dates in every country on the surface of the earth.

The advantages to be derived, with the complications and confusion to be avoided, have been elsewhere set forth. Suffice it to say here, the object to be attained is the establishment of a more accurate and more convenient system of time-reckoning than now obtains. It is not proposed to interfere in the least with the local divisions—the weeks and the days of the week. The week is an arbitrary division, but it has been recognized by man from remote antiquity, and it is a period recorded in the earliest teachings of religion and history.

Amongst the many changes which were violently enforced by the French Revolution, there was perhaps none that more shocked public sentiment than the alteration of the ancient calendar by the substitution of a ten-day period for a seven-day period. The week, as well as the week day, has become an integral part of our civilization, and we must accept both as unalterable. As regards the earth as a whole, both are governed by local and superficial phenomena occurring in perpetual succession around the circumference of the sphere; yet this is no barrier to the establishment of a mode of scientific reckoning determined in harmony with them, and cosmopolitan in its character. The aim is to introduce a scheme whereby years and months, hours, minutes and seconds, at all the meridians of the globe, shall be practically as well as theoretically concurrent; for the division will be based on the one unit measure, an established period in absolute time. However variable may be the ordinary weeks and week days as they occur in different localities around the globe, the effort is to secure to mankind, by a simple uniform system of universal application, the means of truly notating dates, and recording events as they transpire.

To accomplish this end, the first requisite is that each revolution of the globe on its axis be defined by a line of demarcation on the earth's surface acceptable to all nations. The interval of time between two consecutive passages of the sun over this line would denote the unit measure. By whatever name they may be known, the number of these units, from the commencement of a month or of a year, would indicate any particular date, common to all. The unit measure would be divided into twenty-four. These divisions repre-

sented on the surface of the globe by twenty-four fixed meridional lines, at one hour's distance from each other, would establish the standards for local time everywhere. Perfect uniformity would thus be secured in all the clocks in the world. The minutes, and indeed all the sub-divisions of time, would be concurrent; the local numbers of the hours only would differ.*

The position of the twenty-four secondary meridians is governed by the selection of a primary meridian; and hence the first step to the consummation of the scheme is the establishment of an initial meridian as a common starting point.

Is it too much to affirm that the meridian suggested will fully meet every requirement? To the writer it seems, that with the concurrence of those nations acknowledged as the fountain heads of civilization, it might at once take the place of all other initial meridians which have hitherto been employed. It could be established without any clashing with existing customs, or any violent departure from the rules and practices and traditions of the great majority of mariners. By its adoption the expression so familiar to us, "the longitude of Greenwich," would simply pass out of usage, and some other name take its place. There would be no favoured nation, no gratification of any geographical vanity. A new prime meridian so established would be essentially cosmopolitan, and would tend towards the general benefit of humanity. As the line of demarcation between one date and another it would be of universal interest, and a property common to the hundreds of millions who live on the land, and the hundreds of thousands who sail on the sea.

Since the foregoing was written, I have seen the weekly edition of the *Times* of the 17th ultimo. (Jan. '79). The following extract

* One of the unavoidable, results might be held to be objectionable, but, it may prove less disadvantageous than anticipated. Only on one meridian would the ordinary local day correspond with the unit of time. 15° west of that meridian it would be one hour later, 30° west it would be two hours later; and for each 15° degrees of westing one hour later still. Thus the epoch of change from one cosmopolitan date to another would occur at midnight in one locality, at noon in another, at six a.m. at a third, and at every hour of the 24, as the longitude would determine. This peculiarity would doubtless be felt to be an inconvenience during a brief interval of transition from the present to the new system. The accompanying plate illustrates the variation of changes, and shows that, while cosmopolitan time would be absolutely identical in every locality, local time would vary one hour at each fixed local standard around the circumference of the globe.

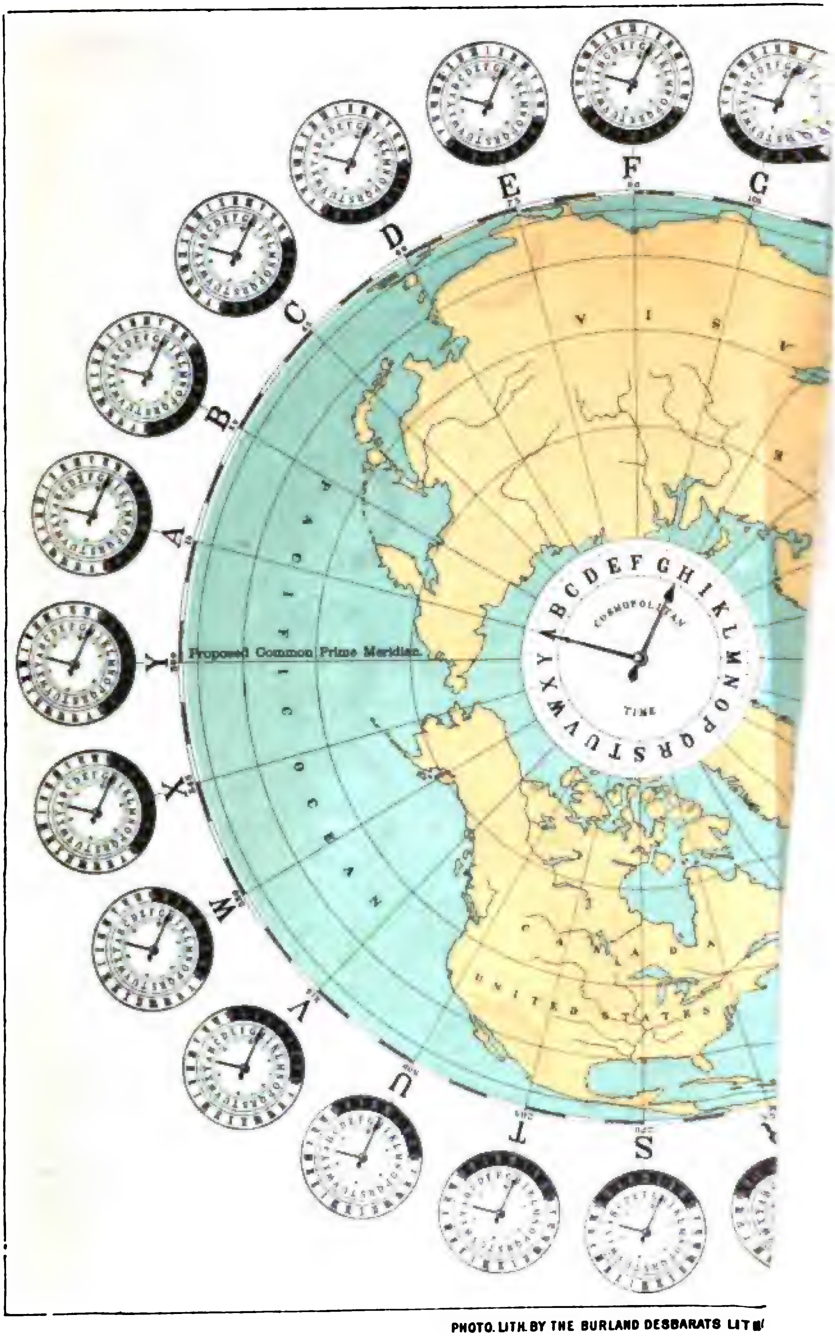


PHOTO. LITH. BY THE BURLAND DESBARATS LITH

which it contains shows that the subject we have been considering is engaging the attention of eminent geographers in Europe:

"A NEW FIRST MERIDIAN.—It is admitted by geographers that the present variety of 'first meridians' is extremely embarrassing and not conducive to accuracy. A good many proposals have been made recently for the establishment of a common first meridian for all countries, but, as one might expect, there is a want of agreement as to what line should be chosen. The question was taken up at the last International Congress of Geography at Paris, and among the contributions to the subject was a paper by M. Bouthillier de Beaumont, President of the Geographical Society of Geneva. The subject was brought on a former occasion before the Antwerp Geographical Congress, where it was very thoroughly discussed by competent geographers. The proposal, however, did not receive more than expressions of sympathy and encouragement. To propose, as M. de Beaumont says, to take the meridian of Greenwich or any other national meridian as the initial one, is not to advance the question; rather, it leaves it *in statu quo*. Nor would it be a happy solution to take the old meridian of Ferro, abandoned by the chief maritime nations and presenting peculiar difficulties in its actual position. At the Congress of Paris of 1875 Jerusalem was proposed, a proposal more creditable to the heart than the head of the professor. Now M. de Beaumont asks: 'Does there exist and can we find a meridian which, by its position on the earth, is sufficiently determined to be taken as the initial meridian, solely on account of its natural and individual character?' In reply he draws attention to the meridian passing through Behring's Strait, as satisfying beyond any other this demand. It is now the 150th meridian west of the island of Ferro, or 30 deg. E., or 10 deg. E. of Paris. This meridian, M. de Beaumont maintains, can be very easily connected with works based on the principal meridians of Ferro, Paris, Greenwich, &c. It touches the extremity of the American continent at Cape Prince of Wales; traverses, on the one hand, the whole length of the Pacific without touching any land, and, on the other, all Europe, through its centre, from the top of Spitzbergen, passing Copenhagen, Leipsic, Venice and Rome; then cuts the African continent from Tripoli to Cape Frio, about 18 deg. S. lat. M. de Beaumont urges several advantages on behalf of this new meridian. It would cut Europe into east and west, thus giving emphasis to a division which has been tacitly recognized for ages; it presents about the largest possible terrestrial arc, from 79 deg. N. to 18 deg. S. lat., 97 degrees altogether, thus giving to science the longest continuous line of land as a basis for astronomical, geodetic, and meteorological observations, and other important scientific researches. Passing as it would through a great number of States, it would become a really international meridian, as each nation might establish a station or observatory on the line of its circumference. Such a meridian M. de Beaumont proposes to call mediator, on the analogy of equator. This proposal of M. de Beaumont is strongly approved by the eminent French geographer, M. E. Cortambert, and has received considerable support from other continental geographers. Whether M. de Beaumont's particular proposal be generally accepted or not, there can be no doubt of the

advantage of having some common international arrangement as to a common meridian for geographical purposes at least."

It is somewhat remarkable that the important query of M. de Beaumont is one which, without the slightest idea that it had been asked by him, I have anticipated by my reply. The coincidence, however, is less strange, that we have arrived substantially at the same conclusions. A Behring's Strait meridian is almost the only one which, by its position, may be taken as the initial meridian, on account of its natural and individual character.

It is not a little satisfactory to discover that the views which I have expressed are confirmed in the main by so distinguished an authority. What difference exists is in matters of detail. M. de Beaumont proposes that the common meridian should be established 150° west of Ferro, or nearly 180° from a meridian passing through or at no great distance from Copenhagen, Leipsic, Venice and Rome. This would throw the initial meridian a little to the east of Behring's Strait; while the one suggested by the writer is to the west in the same locality. Either would perfectly serve the desired purpose. The only question remaining is, which of the two would least interfere with present practices; least disarrange charts, tables and nautical nomenclature; which would most accommodate and best satisfy the greatest number of those who use and are governed by the maps and forms and astronomical almanacs now in use;—in fact, which of the two lines would most readily meet with general concurrence? I think the answer is conclusive. The anti-meridian of the one proposed by M. de Beaumont, passes through Copenhagen—a meridian recognized probably by less than one per cent. of ocean-going vessels; while the anti-meridian of the line advocated in this paper is in use for reckoning longitude by at least 72 per cent. of the floating tonnage of the world.

The proposal of the President of the Geographical Society of Geneva, supported as it is by M. E. Cortambert and other continental geographers, advances the settlement of an extremely embarrassing question, and encourages the hope that at no distant day there may be an international arrangement, through which mankind may secure the advantages of a common first meridian for geographical, chronometrical and all other general purposes; one that in its actual and in its astronomical sense will be indeed cosmopolitan.

Two communications on the subject have lately appeared in the "Bulletin de la Société Geographie, Paris, 6th Series, Vol. 9."

The first, originally submitted to the Imperial Geographical Society of Russia by M. Otto Struve, Director of the Pulkova Observatory, was subsequently read before the Geographical Society, Paris, by M. le Comte Guidoboni Visconte. The second, was communicated to the same society by M. A. Germain, Ingénieur Hydrographie.

The recommendation of M. Germain is that the meridian of Paris should be maintained. He takes an essentially national and non-cosmopolitan view of the subject. The line of argument adopted by him does not call for refutation, even if controversy in this instance fell within the province of the writer.

M. Germain seems to think, for his opinions are not positively expressed, that if England would adopt the metrical measurement of France, it would be a gracious act for France to accept the prime meridian of England.

The communication of M. Otto Struve is of a different character. He argues for the necessity of a common first meridian, in the general interests of navigation, of geography and of astronomy. He points out that national vanity seems to have been the sole cause that up to the present time, to the great detriment of scientific advancement, different first meridians are in use. He very correctly writes: "La question de l'unification des méridiens ne dépend d'aucune considération d'économie politique, elle intéresse uniquement le monde savant. Sa réalisation n 'exige pas certains sacrifices de la part du public; elle demande seulement quelques concessions d'habitudes et de préjugés nationaux, et cela, de la part de ceux-là mêmes qui, après une courte période de transition, en tireront les plus grands profits. Cela est exclusivement l'affaire du monde scientifique, et nous espérons qu 'aucun de ses membres ne refusera de faire les insignifiantes concessions dont nous parlions pour parvenir à cette entente d'une utilité générale."

M. Struve's paper will well repay perusal. His remarks are totally free from national bias; he favours the adoption of the Greenwich meridian in preference to any other, mainly on account of the fact that the exact and the most useful ephemerides published, known under the name of the "Nautical Almanac," are calculated to correspond with it. He admits, however, that it is impossible to disregard the influence of national jealousies, and he points out how much they stand in the way of obtaining a general recognition of any first meridian established on national grounds.

The conclusions to be drawn from the valuable paper of M. Otto Struve are, that although he gives the preference to Greenwich as a common first meridian, that a meridian passing through the ocean, away from every country, and an exact multiple of 15° from Greenwich, would be a simple and desirable alternative.

The Pacific meridian advocated in the present paper meets these conditions, and in itself offers many positive advantages. It passes through the ocean without meeting any continent, except uninhabited land on the Arctic circle. The Nautical Almanac, recognized by M. Struve, and by the leading astronomers of the world, to be the most complete work of the kind published, and in consequence the most generally used, would apply to it without interpolation. And as no national jealousy would be awakened, all national objections to the initial meridian proposed would entirely disappear, and its general acceptance be considered a ready and harmonious solution to an embarrassing difficulty in a matter of the greatest scientific importance.

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NOTES ON MANITOBA.

NOTES ON THE PHYSICAL PHENOMENA OF MANITOBA AND THE NORTH-WEST TERRITORIES.

FROM OBSERVATIONS MADE DURING EXPLORATIONS IN 1872, 1875, AND 1879.

BY JOHN MACOUN, M.A.

The region to which the following remarks will mainly apply is bounded on the south by parallel of Lat. 49°; on the north by parallel of Lat. 60°; on the east by meridian 95°; on the west by the line of the Rocky Mountains. An area, in round numbers, of 667,600 square miles.

For many years this vast region was almost a blank on our maps —little was known of it, either by Englishmen or Canadians, beyond the fact that furs were obtained therefrom. It was not so, however, with the Americans. More than twenty years ago they recognized its value, foretold its great future, and even described it as the prospective granary of the world.

In 1857, Capt. Palliser was commissioned by the British Government to examine the country south of the 54th parallel. Commencing his examination at the international boundary, in the vicinity of the Red River, he made a few traverses and reached Fort Ellice late in season. Proceeding up the right bank of the Qu' Appelle to its head, he crossed the South Saskatchewan and proceeded northward to Carlton, where he wintered. In June, 1858, he turned to the southwest and spent the summer on the Great Plains, wintering that year at Edmonton. In the following spring he again proceeded south to the boundary, but afterwards passed to the west into British Columbia.

He reported in very favorable terms of the northern portion of the country that he had traversed, but of the southern portion he spoke much less favorably—alleging that running water was very scarce; that no wood was to be seen except in the river valleys; and, that owing to the enormous herds of buffalo which covered the plains at that time, feed in many places was poor.

As far as public opinion was concerned the only immediate result of this exploration was that a certain district in the north became

known as the "Fertile Belt" and that the southern part about which so little was said, was set down, or assumed, to be arid and of slight value; an opinion still generally prevalent and mainly fostered by writers whose views have been based on a misinterpretation of Capt. Palliser's remarks.

The survey of the International Boundary and the establishment of the Mounted Police Force in 1874, tended in some degree to dispel the cloud which hung over the south. Their frequent journeys have done much since then in the same direction, yet in the minds of the general public, and even of many others who should be better informed, the old prejudice, in a measure, exists against it.

In this position of the question the past only repeated itself. How many are the instances of wealth unknown having passed for centuries under the eye of the dwellers on the spot unappreciated and untouched?

In our day the growth of the Dominion, demanding a through communication from east to west, and the exigencies of the over-populated countries of the old world, have brought it about, that we should be the means of enlightening the world as to the extent of the resources of the "Great North-West," and in so doing, possibly of acting as special agents, fulfilling the beneficent intentions of the all-wise Creator.

Explorers have traversed its length, and settlers have here and there dotted the new land and the reports of one and the other only stimulate us to further research.

Amongst those sent out to explore, I was first commissioned by Mr. Fleming, in 1872, to examine the flora of the prairies between Winnipeg and Edmonton. The same year I was despatched in company with Mr. Charles Horetzki to explore the Peace River and examine the country on its banks. The results were the discovery of the low passes through the Rocky Mountains and of an extensive tract of fertile country, since known as the Peace River District.

In 1875, I accompanied Mr. Selwyn, Director of the Geological Survey, in the capacity of botanist, to British Columbia and from thence by the Peace River Pass to the east of the Rocky Mountains. Circumstances compelled me to descend the Peace River from the Rocky Mountains to Lake Arthabaska and I was thus enabled to see the country as far north as lat. 59°. Turning eastward at this point a journey of 1,200 miles brought me to Winnipeg.

The general conclusions which I arrived at from my explorations of 1872 and 1875 were: 1st, That as there was but one flora common to the region extending through from eight to twelve degrees of latitude, or as far north as 60°, and as that flora required a high summer temperature for its existence, the thermometer would be found to show a correspondingly even distribution of heat throughout the whole region.

2nd. That exceptional or special conditions must exist to produce that high and even distribution of heat discovered as ranging over so great an area.

These conclusions have since been established as facts by the recorded observations sent in from the Meteorological Stations at Winnipeg, Fort McLeod, and Fort Calgarry in the south, and Fort Rae and Fort Simpson in the north. (See Meteorological Report for 1878.)

In 1879 my attention was mainly directed to an investigation of the causes of the supposed aridity of the district lying to the south. I found a parched surface, dried and withered grasses, and in short, every appearance of the existence of such aridity; but closer examination showed that these indications were illusory. At the point, "Blackfoot Crossing" lat. 50° 43′ where the consequences of aridity appeared the strongest, I came upon ground, broken up in the spring, bearing excellent crops of all kinds—oats being four feet high, while on the land outside the fence the grass was burnt up and all other vegetation withered. From this I argued that the rainfall in the district was evidently ample for the requirements of vegetation, but that, until the baked crust was broken, it could not percolate the ground as rapidly as it fell and so a great portion was evaporated by the dry atmosphere and lost. Thus the apparent aridity vanishes before the first efforts of husbandry. Next to the question of aridity was that of the high and even temperature of climate. On this point I simply accumulated data bearing on the observations of former years, all of which tended to prove that the great plain to the north-westward, and north of lat. 49°, extending along the Saskatchewan and other rivers between the 100th and 115th meridians, and the narrow strip of coast north of Montery, California, present decided features of difference from other districts of the American continent. These differences and peculiarities I shall now deal with *seriatim*.

TEMPERATURE.

It was long ago asserted as a principle by Geologists that, "land in quantity situated to the southward of lat. 40° north very materially raises the temperature of lands lying so the north of such parallel." (Sir C. Lyell.) To the expression "land in quantity," I would add *when its character is that of a desert or arid nature.* Another maxim has been laid down by a well known writer on American Climatology (Blodgett) "that high arid plains are indicative of great summer heat, of an arid atmosphere, and of little rain or snowfall. Now the conditions required to test the accuracy of both these propositions are presented in the position occupied by the North-West Territory. South of our boundary within the United States lies a vast tract of land, generally arid or desert, of which at least 500,000 square miles are embraced in a plateau which has a general level of 6,000 feet. At Laramie City, in lat. 42° it is about 7,000 feet above sea level, from thence northward it rapidly falls off so that when it reaches our boundary in lat. 49° at Pembina, it is considerably under 1,000 feet. At the base of the Rocky Mountains it is under 4,000 feet. From the boundary the plain extends far to the north and only terminates at the Arctic Sea. In such a wide range of latitude it might well be expected that a considerable difference of temperature would be found. The following Table, however, shows the temperature as being wonderfully uniform :—(See Metereological Report, 1878.)

PLACE.	Lat.	Long. W.	May.	June.	July.	Aug.	Mean of Summer Months.
Winnipeg	49.53	97.07		59.2	65.8	63.3	62.8
Fort McLeod..	49.39	113.42		60.6	63.3	57.0	60.3
Norway House.	54.00	98.00		54.9	63.5	61.2	59.9
Fort Simpson. .	61.52	121.25		58.8	63.4	63.2	61.8

In the same parallels of lat. in Europe the temperature is recorded as follows : (See Blodgett.)

PLACE.	Lat.	May.	June.	July.	Aug.	Mean of Summer Months.
Penzance, S.W. England	50.08		59.5	62.1	61.1	60.9
Cracow, in Poland	50.04		64.0	65.8	64.9	64.9
Konigsberg, in Prussia..	54.42		57.4	62.6	61.7	60.6
St. Petersburg, in Russia	59.56		58.2	62.7	60.8	60.6

We therefore see that the summer temperature of the North-West Territories is exceptional, and may be taken as confirmatory of the views quoted. Believing, however, that in addition to the quoted causes, there are others which contribute to this result of exceptional temperature, I purpose, for the present, to treat it simply as a fact to be noted for further comment, and pass on to the subject of isothermals. The recorded lines of equal temperature show that the various lines of heat, as they make westing from the eastern coast of the continent, tend in summer to curve upwards from the Gulf of Mexico in a north-westerly direction to a point in lat. 50° long. 110° west. At this point the mean summer temperature is 70° F., while at Winnipeg, on the same parallel of lat., but 15° farther east, the temperature is but 65°. Tracing these isothermals still further north, the line of greatest heat passes near Fort Vermillion in lat. 58° 24′ and long. 116° 30′ W. I may mention that at this point I found barley cut on August 6th, 1875, and wheat almost ripe. Still farther north and west, the table shows that Fort Simpson has a mean summer temperature of 61°.8 F. Turning to the west coast, the isothermal lines commence to turn northward from the Gulf of California, and for a time skirt the western side of the Rocky Mountains. On reaching the low point of the chain between lat. 41° and 45° they turn to the east, cross the mountains, and strike the Dominion boundary on the 115th meridian. These westerly currents, named the "Chinooks," have been known to cause a rise in the temperature of 60° in a few hours. When in that country I enquired from a half breed about their effect on the snow. His reply was, "the Chinook licks up snow, water and all."

After crossing the Rocky Mountains the thermometric current of the west meets that of the east at or about Hand Hills in lat. 51.20°, long. 112°. There, in 1879, I found that for days together, during August, the thermometer in the shade registered from 87° to 92° F. From the Hand Hills the united currents following their resultant direction carry the temperature (of latitude extending almost to New Orleans) over the plains of the North-West, and confer on it the blessing of a climate, not only exceptional as regards character, but productive of results to the agriculturist, which, I believe, are unsurpassed in any other part of the world.

Returning, however, to the course taken by the east and west currents before their union at the Hand Hills, it is a matter for con-

sideration, why that from the east should depart, not only, from the natural law which would give to it an eastward, in place of a westward, bend as it rises northward from the Gulf of Mexico, but also from that of the western current which follows the natural law and bends to the eastward.

The answer to this question is *the key and the solution of almost every climatological peculiarity of the North-West.*

The data which we have for the investigation of the question: Why does the eastern current of heat proceeding north-westward from the Gulf of Mexico bend to the west? are:

1st. Recorded observations which show that land of a desert character is heated to a greater degree than that without its bounds.

2nd. Recorded observations which show that currents of air are constantly on the move to the spots where the land is most heated.

3rd. The fact that to the westward of the tract running northward from the Gulf of Mexico lies the "Great American Desert," which, from the preceding statements, must exercise an influence on the air around it.

To my mind, no argument is needed to show that the cause of the divergence of the eastern thermometric current to the westward is solely due to the position and effect produced by the American Desert. A confirmation of this inference is offered in the eastern hemisphere where the south-east trade winds are drawn out of their course by the heated atmosphere of Western Indies, and result in the South-West Monsoon, and further by the north-eastern trend of the isothermals in Northern Asia. In the transition from summer to winter we find the Desert losing its temperature (terrestrial and atmospheric), and consequent attractive influence on air currents warmer than its own, the first effect of which is that the isothermals pass away from their northern altitude and sink southward next, when freed from the desert influences, they no longer trend to the westward, but to the eastward. On the withdrawal of the southern warm currents, other currents from the north and from the west follow them up, particularly on the east side of the Rockies, and establish the prevailing north-west winter winds, which, being affected by the temperature of the Arctic Regions on the one hand, and by the Mountains on the other, bring the minimum line of cold so far to the south. Were the American Desert an inland sea, the summers of our plains would lose their exceptional character, and our winters would be like those of Eastern Europe.

In a paper like the present, however, it would be out of place to discuss the climate of the eastern hemisphere; but it could be shown that precisely similar causes to those which I have specified can be traced as existing there, and as being productive of the same results.

HUMIDITY.

The rainfall of the North-West offers as favorable a contrast to that of other districts as the temperature has shown. Rains come just when they are wanted and cease when vegetation not only no longer requires them, but when their continuance would be injurious and detrimental to harvesting. Formerly the rainfall of a country was judged by the average for the whole year. Such a comparison, however, is misleading. What we want to know is the quantity that may be expected to fall:

(a) During the period of vegetation and its distribution month by month. (b) During the harvest months.

The period of vegetation in the North-West embraces May, June, July and August. The harvest months are September and October. To show how favorably these two conditions are determined for the North-West I append the following tabularly arranged statements of rainfall:

TABLE I.—FOR THE FOUR MONTHS OF VEGETATION.

PLACE.	Position.		Rainfall in Inches.				Total for 4 Months.
	Lat.	Alt.	May.	June.	July.	Aug.	
Winnipeg, N. W. T.	49·53	7·40	2·17	3·42	2·68	7·11	15·37
Toronto, Ontario....	43·39	3·50	2·98	3·04	3·72	2·81	12·55
Fort Riley, Kansas..	9·03	13·00	4·14	3·08	1·08	2·99	11·29
Rochester, New York	43·07	5·06	3·04	3·25	3·01	2·60	11·90

TABLE II.—FOR THE TWO MONTHS OF HARVEST.

PLACE.	Position.		Rainfall in Inches.		Total for 2 Months.
	Lat.	Alt.	Sept.	Oct.	
Winnipeg, N. W. T.	49·53	70·40	0·73	0·03	0·76
Toronto, Ontario....	43·39	3·50	4·45	2·96	7·41
Fort Riley, Kansas .	39·03	13·00	4·18	0·02	4·20
Rochester, New York	43·07	5·09	3·05	3·39	6·41

Having stated what the recorded facts as to rainfall are, I will give my reasons for asserting that these facts are but the necessary consequences of the physical conditions existing in the West of the North American Continent.

In the early part of this paper I referred to the position of the Great American Desert and pointed out one of its effects on the air currents rising northward from the Gulf of Mexico—viz,, its power to attract and draw them to itself, and to the westward of their natural course. Another effect, now first mentioned, is that arising from the heat given off from the surface by radiation during the summer months. The Gulf air currents, laden with moisture, when drawn over the desert are met by the rarified and heated air ascending from its surface, and that rainfall which in the ordinary course they would shower down (being prevented from falling) passes on and is wafted by the prevailing winds in the direction of our North-West, where, being removed from the effects of the desert heat, they give forth their long borne and priceless load in the form of our summer rains.

Having shown cause for the summer rains, I may, now, state that the simple "suspension of those desert effects which gave the summer rains" is the cause of the almost total absence of rain in the autumn and winter periods.

It was shown when writing on the winter temperature that as the desert cooled down the main air currents from the Gulf of Mexico no longer pursued a westward course but passed to the eastward. This change of direction takes them over the region of the Canadian Lakes where they deposit that rainfall which in summer fell on the plains of the North-West.

AGRICULTURAL OPERATIONS.

The progress of the seasons and the labours of. the husbandman may be summarized as follows :

Early in April the hot and unclouded sun clears from the lands the last of its light snow-covering—thaws, and at the same time dries the ground sufficiently to fit it for the plough—and almost simultaneously for seeding. Germination quickly follows and the young roots, moistened by the thawing of the subsoil, follow the pores opened out by the disintegrating power of the winter frosts, and penetrate to a depth inconceivable to those who have not put the

matter to the test. By the time that the rains of May and June come the roots have a firm hold of the ground, and growth is extraordinary. The July and early August rains nourish and swell the ear of the now ripening crops, and complete the promise of the early spring. Towards the end of August the winds change and the almost rainless period sets in and continues all winter. The Farmer harvests his crop without loss and in the highest possible condition; stacking it in the open without even the necessity of thatching it for the winter.

TO STOCK BREEDERS

The advantages are equally great. Storms of sleet or wet snow are unknown on the Western Plains. Such snow as does fall is always dry and light, hence cattle and horses may be left out the whole winter without the possibility of suffering from wet. Intense cold they may experience, but stock-raisers know that where such cold is dry their cattle take no harm. Hence cattle can be, and are raised, on the North-West Plains without the necessity for buildings for wintering them.

SOME OBSERVATIONS ON THE PHILEBUS OF PLATO,

THE POSITION OF THE ROWERS IN THE WAR-SHIPS OF THE ANCIENTS, &c.

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Euripides, *Iphigenia in Aul.* v. 808. In this line, Dindorf and others have taken exception to the word ἄπαιδες—for which some read with Bothe εὔπαιδας, while others adopt Musgrave's conjecture καὶ παῖδας. Properly understood, ἄπαιδες seems to me preferable, not only as being the MSS. reading, but also in point of sense.

Achilles states that the men of the expedition, chafing at their detention at Aulis, are not all similarly situated: Some, like himself, ἄζυγες γάμων Οἴκους ἐρήμους ἐκλιπόντες, others ἔχοντες εὔνιδας Ἄπαιδες. Here he pauses in his enumeration—τοὐμὸν μὲν οὖν κ.τ.λ., "others may speak for themselves, he will state his own case." As I take it, ἔχοντες εὔνιδας κ.τ.λ. should be rendered "others, although they have wives, have no children." These, then, would belong to the class specially exempt from military service, under the Mosaic dispensation (cp. Deuteronomy, ch. XX. v. 7; XXIV. v. 5). Hence the force of the following parenthesis—οὕτω δεινὸς ἐμπέπτωκ' ἔρως κ.τ.λ., "so constraining a desire for this service hath befallen Hellas."

Ibid. v. 1143.

Those who have adopted Porson's alteration of κάμνῃς into κάμῃς, seem to have overlooked the fact that the imperative force is neither absolutely necessary nor, as I think, desirable. Agamemnon, dumbfoundered at finding his designs discovered, lets falls the exclamation, "I am lost! my secret is betrayed!" While he is hesitating and thinking what to say next, Clytemnestra sarcastically resumes, "I know all! your very silence amounts to a confession, *so that you need not weary yourself* with a long and idle story." Of course, if we retain κάμνῃς, the period after πολλά must be removed.

Homer, Iliad, B. XVIII. v. 119. ἀργαλέος χόλος suggests itself to me as the original of Horace's "*splendida bilis*" (Sat. II. iii. 141). I have never been able to persuade myself that such a master of epithets, as Horace undoubtedly was, would have allowed himself to use such an apparently meaningless epithet as *splendida*, without some special reason. Now this verse of Homer's would seem to have passed into a proverb (the description of χόλος, in the verses immediately preceding it, is quoted by Plato, *Phileb.* 47 E.); and it is probable that Horace, with this phrase of Homer's floating idly in his memory, wrote *splendida* as a translation of ἀργαλέος, not stopping to reflect that this word was from a different root than the similar sounding derivatives of ἀργός "bright and glistening." Horace himself tells us, in more than one passage, that he repeatedly conned the Homeric poems; and we frequently find scraps from the Iliad and Odyssey, literally rendered and introduced, apparently, quite as much for the purpose of displaying Horace's archæological lore, as from the appositeness of the quotation. If this assumption of mine be correct, it curiously illustrates Pindar, *Pyth.* IV. v. 109. λευκαῖς πιθήσαντα φρεσίν—where it has been suggested (Donaldson's note *ad locum*) that Pindar has miscopied Homer's φρεσὶ λευγαλέῃσι πιθήσας. Apropos of derivations, I find, in the Lexica, the word ἀμυδρός variously derived from ἀμαυρός and from an Indo-European *madra*. A much simpler derivation would be from the Homeric ἄμυδις "all together," *i.e.*, *confusus* as opposed to *distinctus*.

Xenophon, *Anab.* V. vii. 25. καὶ ἐπνίγετο ὅστις νεῖν μὴ ἐτύγχανεν ἐπιστάμενος. This passage illustrates, in the most striking manner, the necessity for attention to the distinctions of tense in the Greek verb. I have never seen it correctly translated. Xenophon is deploring a tumultuous spirit which had developed itself among the soldiers. He says that, owing to their menacing behaviour on a certain occasion, many people had been so much alarmed that they had cast themselves into the sea in their efforts to escape, "and whoever did not happen to know how to swim *was in a fair way for being drowned.*" If ἐπνίγετο had signified "*was drowned,*" as it is usually rendered, Xenophon would not have failed to dwell upon the loss of life occasioned by this outrage.

Livy, B. IX. cp. 16, furnishes an example of a far more amusing, but perhaps more excusable, mistranslation than the above. Writers of Roman history gravely tell us that Papirius Cursor was such a

martinet that, according to Livy, when his troopers applied to him for some relaxation of their discipline, he replied: "Yes, I will relieve you from the obligation of giving a pat to *your horse's* back when you dismount." The words are "*ne nihil remissum dicatis, remitto, 'inquit,' ne utique dorsum demulceatis, quum ex equis descendetis.*" If any one, who has ever ridden without a saddle, will recall his first instinctive movement on dismounting, *equo lassus ab indomito,* he will have no doubt either as to the nature of the action or the owner of the *dorsum.*

Plato, *Repub.* B. X. 615. D. I cannot see why *ἂν ἥξει* should be retained (as one of the exceptions to the rule against *ἄν* with Fut. Indic.), when the sense plainly requires *ἀνήξει*—*i.e.* "*neque adest neque adfuturus est ex inferis.*" The speakers have ascended, Ardiæus is still below, *cp.* 615. E.

Plato, *Philebus,* 17. B. *καὶ οὐδὲν ἑτέρῳ γε τούτων κ.τ.λ.* It has been objected to this reading, that the sense requires *οὐδετέρῳ.* I am inclined to think that the original was *οὐδενὶ ἑτέρῳ*, and that the letter *ι* has suffered elision at the hands of the copyist.

Ibid. 18. B. *μὴ ἐπὶ τὸ ἓν εὐθὺς ἀλλ' ἐπ' ἀριθμόν αὖ τινὰ πλῆθος ἕκαστον ἔχοντά τι κατανοεῖν, τελευτᾶν τε ἐκ πάντων εἰς ἕν.* Stallbaum says that all the MSS. agree in exhibiting this reading; however, as he finds it unintelligible, he concludes that there is a mistake somewhere. He would read *ἑκάστοτε*, in which sense some commentators have wished to explain *ἕκαστον.* If it does not savour too much of presumption, I should say that the error arose from their not perceiving that *ἕκαστον* was in construction with *ἀριθμόν*—not with *πλῆθος.* I consider *πλῆθός τι* as the object of *ἔχοντα*, and the sentence *πλῆθος ἕκαστον ἔχοντά τι* as a parenthesis; *ἕκαστον* then would mean each of the subordinate *genera*—("each" of the "two or three, &c.," 16. D.). The rest of the construction might be explained thus: *δεῖ βλέποντα . . . κατανοεῖν αὐτὸν* (*τὸν ἀριθμόν scil. ὁπόσα*).

Ibid. 19. C. *ἀλλὰ καλὸν μὲν τὸ ξύμπαντα κ.τ.λ.* I am surprised that Stallbaum has not noticed a manifest reference to the old proverb, "*primus qui ipse consulit, &c.*" Cp. Hdt. VII. 16; Sophocles, *Antig.* v. 720; Livy, XXII. 29.

Ibid. 20. D. *ἀναγκαιότατον.* The meaning of this word is obviously "*the least one could say.*" This sense of *ἀναγκαιότατος* is frequently lost sight of, *e.g.*, in the Gorgias 505. E., where (as I pointed out, in the Journal of the Canadian Institute for 1872) the idea conveyed

is that the dialogue, if carried on by Socrates alone, would be a very poor affair, cp. Repub. 369. D.

Ibid. 30. E. *νοῦς ἐστὶ γενούστης τοῦ πάντων αἰτίου λεχθέντος τῶν τεττάρων ὧν ἦν ἡμῖν ἓν τοῦτο.* This is indeed a much vexed passage; Stallbaum defends *γενούστης*, which is evidently a play upon the jingle *νοῦς* and *γένους*, on the ground that Hesychius and Suidas both mention it as a word used by Plato, as a synonym for *γεννήτης* or *συγγενής*, but gives up the latter part of this passage as a "*locus manifesto corruptus.*" For my own part, I cannot see the necessity for despair. In 30. B. the four *γένη* are enumerated: *πέρας καὶ ἄπειρον καὶ κοινὸν καὶ τὸ τῆς αἰτίας γένος, ἐν ἅπασι τέταρτον ἐνόν*; and, as far as I can see, the two statements are exactly parallel.

Ibid. 40. E. *τί δέ; πονηρὰς δόξας καὶ χρηστὰς ἄλλως ἢ ψευδεῖς γιγνομένας ἔχομεν εἰπεῖν.* For the omission of *καὶ ἀληθεῖς*, in addition to other parallels, one might compare the customary ellipse with *ἐν μέσῳ*, *e.g.*, Aristophanes, *Av.* v. 187. *ἐν μέσῳ δήπουθεν ἀήρ ἐστι γῆς*, and Euripides, *Phœniss.* v. 583.

Ibid. 44. D. *δυσχεράσματα.* This word, which Pollux mentions with disapproval and Lobeck condemns, although manifestly a reading of the highest antiquity, is, I am tempted to believe, a corruption arising from the confusion of *δυσχερείας* with the *μετά* of the following sentence. The bastard *δυσχεράσματα* would, I think, be the natural offspring of *δυσχερείας μετά.* The union of the two words being brought about by the feeling that a neuter plural, agreeing with *τἆλλα*, would suit the construction much better than the somewhat awkward *δυσχερείας.*

Ibid. 46. E. Stallbaum reads *ἀμηχάνους ἡδονάς, τότε δὲ τοὐναντίον τοῖς ἔντος πρὸς τὰς τῶν ἔξω λύπας ἡδονὰς ξυγκερασθείσας κ.τ.λ.*; but says "*προστάττων* Bodl. Ven. II. *Dein libri omnes ἡδοναῖς, quod de coniectura Schützii in ἡδονάς mutavimus.*"

I am inclined to think that *προστάττων* is really *πρὸς τὰ τῶν*, it being a frequent practice in MSS. to represent double letters by a letter of larger type. Hence recurrent letters are often omitted, and *vice versa*, according as the eye of the copyist was attracted by a difference in the size of the letter. Here I believe that the original reading was—*τοὐναντίον τοῖς ἔντος πρὸς τὰ τῶν ἔξω, λύπας ἡδοναῖς ξυγκερασθείσας κ.τ.λ.* I consider *τοὐναντίον—ἔξω* as a parenthesis, and would translate thus: "Sometimes inconceivable pleasures, and at others (*the contrast between the internal and the external*

sensations) pains mingled with pleasures." With regard to the construction, τούτοις πρὸς ἐκείνους is the ordinary mode of expressing enmity or opposition between two parties.

Ibid. 47. C. περὶ δὲ τῶν ἐν ψυχῇ σώματι τἀναντία ξυμβάλλεται. Here, as Stallbaum says, "*deest aliquid ad loci integritatem.*" Buttmann conjectured ἐν ψυχῇ καὶ σώματι, ὅταν ψυχὴ σώματι τἀναντία ξυμβάλληται, which suits the sense admirably, but is too violent a remedy. Ast imagines that ᾗ has fallen out after ψυχῇ; but, as Stallbaum says, this would hardly suit the sense. I am inclined to think that the most natural remedy would be to supply ᾗ, which would readily be absorbed in the final syllable of ψυχῇ (see note on 46. E.), and would suit the sense equally with Buttmann's reading. I would render—"But concerning those in the soul, where it contributes (to the mixture) opposite sensations to those of the body, viz., pain in immediate contrast with the body's pleasure, &c."

The Trireme.

In a series of papers, which have appeared, from time to time, in the Revue Des Deux Mondes, entitled "La Marine De L'Avenir Et La Marine Des Anciens," M. le Vice-Amiral Jurien de la Gravière, well known as a naval officer holding high command in the Crimean and Mexican campaigns, has examined historically the naval expeditions of the Ancients, with a view to their bearing on the tactics likely to be adopted by modern navies. In the course of his remarks, he finds it necessary to refer to the much vexed question of the *Trireme.* Was the *Triremis* or Τριήρης, of the Ancient Greeks and Romans, a vessel with three banks of oars, one above the other, as the Dictionaries tell us? The answer, which he gives to this question, is that which has been given by every practical seaman, from the old Sieur Barras de la Penne, Capitaine des galères du Roi, down to the present time. All seem to agree that, even if a vessel so constructed might manage to move in smooth water, it would be almost impossible for it to manœuvre in a rough sea, or in the rapid alternations of a naval combat. How then can we credit the existence of such monstrosities as *quinqueremes* and *naves sedecim ordinum,* not to speak of the τεσσαρακοντήρης of Ptolemy Philopator?

Plainly some other solution must be found; for the fact that there were vessels so named is too well attested to admit of dispute. The first idea, which would naturally occur to one, is that these vessels received their names, not from the number of their oars, but from

the number of men at each oar; and this is the view taken by most of the opponents of the theory of three or more tiers of oars. A very strong argument in its favour is derived from the practice on board the war-galleys of the 16th and 17th centuries, in which each oar was worked by five rowers: *quinqueremes* they are called by the advocates of this view of the question. But, reply the others, in this case, how do you account for the terms θρανίτης, ζυγίτης and θαλαμίτης, which, say they, were unmistakably applied to the upper, middle and lower tiers of rowers respectively, and to the oars used by them? Barras de la Penne (following the Scholiast on Aristophanes, *Ranae*), thinks that they received these names from their position, fore, aft or amidships. The θρανίτης, who sat nearest to the stern, was placed higher than the θαλαμίτης, used a longer oar and received higher pay. In his opinion, the confusion has arisen from a failure to realise the well known fact that *remus* is often used with the signification of *remex*; just as we say "a good oar" for "a good oarsman." Certainly many passages, in the Ancient Classics, admit of this explanation; but there are others, in which the supraposition of the one class of rowers seems to be too clearly indicated to be disposed of thus easily. Lastly, the great difficulty has always been the fact that, although, in the great majority of pictures representing war-ships, only one tier of oars is to be seen; still in a few coins and some monuments, notably in the figures on Trajan's column, vessels are depicted, in which we apparently distinguish *two* tiers of oars.

Here, I think, lies the way out of this last difficulty. Why only *two*? "Because there was not room for more on the coins," say the apologists; but this does not apply to the marbles. It has been remarked that, where there are two tiers visible, the oars in the lower tier do not exactly resemble those in the upper tier; and it has been suggested that one of these tiers consists of dummies—possibly, guards to prevent one oar from interfering with the other. It may be objected that such dummies would have materially impeded the vessel's progress, against a wind or through rough water. After reading M. de la Gravière's vigorous protest against the admission of what he has stated to be a practical impossibility—whatever history or the monuments might say to the contrary—I was led to the conclusion that there must be some mode of reconciling fact with tradition; and the following suggested itself to me as not improbable.

One has often noticed in old wood cuts, and in most pictures drawn by children, an attempt to exhibit two opposite sides of an object, without regard for the perspective. Now one way of doing this—one sometimes sees it done intentionally in drawings of machinery—is to raise the outer side above the other. As I take it, in the few instances in which we find a second tier of oars, the artist, knowing that a spectator would see the oars only of the rowers nearest to him, the rowers themselves being partly hidden by the bulwarks, while the rowers on the other side, being further from the intervening bulwarks, would be more conspicuous, wished to bring their oars also into view. No doubt this error in the perspective, once introduced by the original artist, would be carried still further by the copyist, who possibly never saw such a vessel in his life; and this too would explain some of the strange comments which are to be found in later writers. With regard to the supraposition of the rowers, I cannot but think that, especially in very large vessels, where each oar was manned by ten or sixteen rowers, it would be necessary for the men at the upper extremity of the oar to be placed higher than those nearer to the thole pin; otherwise they would hardly have been able to reach the end of the oar when it was dipped in the water. As the upper part of the oar would necessarily describe a greater curve than the lower, it would be natural that the pay of the *Thranite* should be higher than that of the *Thalamite*. In the case of Ptolemy's ship, it is probable that the rowers relieved one another, and did not all row at the same time. When I had arrived at the above conclusion, it occurred to me that the term *θαλαμίτης* admitted of a very significant derivation (it is ordinarily supposed to be connected with *θάλαμος*, *i.e.* "the man who sits in the hold"). The aperture through which the oar projected was called *ἡ θαλαμία scil. ὀπή*; and, as I take it, both these words are derived from *σκαλμός*, "the thole pin" to which the oar was fastened; *σκαλμός* naturally passes into *σκαλαμος*. On calculating the probabilities in favour of this derivation, I came across one or two other words for which it seemed to me more natural to assume a parallel phonetic change, than to assign them to the roots to which they are ordinarily referred: *e.g.*, *θώπτω* is suggestive of *σκώπτω*, *θάπτω* of *σκάπτω* (cp. *τάφρος*). Accordingly *ὁ θαλαμίτης* would be the rower who sat nearest to the thole pin. As I thought that the probabilities were in favour of this view, I ventured to communicate it to the Admiral, who had

expressed his anxiety to obtain some solution of the difficulty; and he, in acknowledging my letter very politely, has condescended to express his satisfaction with my explanation. About a fortnight after the despatch of my letter, I received a very curious confirmation of this derivation, at least in part, from some remarks, which appeared in a following number of the Revue, by M. le Contre-Amiral Luigi Fincati, of the Italian navy, who has criticised M. de la Gravière's statements. M. Fincati, speaking of the Venetian navy, says that the rowers were protected by vertical shields placed above the "armatures" (outriggers) on which the oars worked. These shields, he says, were successively called *talamii*, *talari*, *ali* and *morti*; and the θαλαμίτης was so called, because he sat nearest to the *talamii*. M. Fincati's view, although pronounced impracticable by the French Admiral, is remarkable. He maintains that, until the latter half of the 16th century, the war-ships of the Mediterranean were always, *par excellence*, triremes. The crew was composed of two hundred men; of whom one hundred and fifty were rowers, seated three and three on the twenty-five benches placed on either side of the vessel; he thinks that these benches were arranged obliquely, and that each man had a separate oar; so that the oars reached the water in groups of three, at intervals corresponding with the distance between the benches: but he adds that, about the middle of the 16th century, this arrangement was altered, and the three men rowed with one oar. He cites as his authorities the *Historie del mio tempo* of Natal Conti, the *Armata Navale* of Pantero Pantera, Cristoforo da Canale, and other writers to which I have not access. However, the probabilities seem to be decidedly in favour of M. de la Gravière, who is even less disposed to allow the possibility of this arrangement than of the old one. Just imagine what would happen, with three men on a bench, each having a good long oar in his hand, if one of them chanced to "catch a crab," or was knocked over at a critical moment! his swinging oar would throw the whole equipage into a state of disastrous confusion. In one of the early numbers of the Revue, M. de la Gravière mentions the fact that the Maritime Statutes, of the 14th century, speak of the galleys as *armatae ad tres remos ad banchum* "equipped for three oars to a bench;" and such passages as this are, in all probability, the source of what I cannot help calling the error of M. Fincati and his authorities. Barras de la Penne has warned us that we must not suffer ourselves to be misled by the word *remus*. And, besides, a passage from Zosimus (*flor.* A.D. 420) which has often been cited

on the opposite side, expressly tells us that, although Polybius had described the Romans and Carthaginians as using vessels with six banks of oars, they had ceased to construct even triremes long before his time.

Doletus, indeed, the virulent adversary of Erasmus of Rotterdam, tells us (A.D. 1537) that he saw such a *quinquereme*, at Venice, "*prima adolescentia;*" but, unfortunately, he tells us also that the rowers were placed in tiers, one above the other: an arrangement of which M. Fincati himself admits the impossibility. Now Doletus may be easily disposed of: he is defending himself against a charge of ignorant appropriation from a work by the learned Bayfius; and it is absolutely necessary for him to bring out something original. Bayfius has ended by declaring his doubts as to the possibility of three or more tiers of oars: Doletus finds no difficulty in saying that he has *seen*. No one, who has waded through the foul torrent of invective in which Doletus indulges, would take his word for anything. Moreover, he says "*prima adolescentia*:" let us trust that he had forgotten. After examining with some care the numerous passages cited by Bayfius, Meibomius, Opellius, Scheffer and Voss, I have come to the conclusion that most of them may be satisfactorily explained. Considerable latitude must, of course, be allowed in the case of quotations from the poets—although there is one passage, in particular (Arrian, *Exped. Alexand.* VI. 5), which can only be accounted for on the theory that some interpolator has been at work. Finally, we must not lose sight of the fact that Ancient war-ships were not constructed on such rigidly scientific principles or with such exact workmanship, that barely *possible* positions and *intricate* combinations may be assumed for seating the men and adjusting their oars: on the contrary, the doubt must be given against such; and no arrangement but the simplest and most feasible can be accepted, if we are to believe that, in the First Punic war, the fleet of Duillius was ready to sail within sixty days of the felling of the timber, or that, in the Second, Scipio's was built in still less time. Moreover, we must bear in mind that intricate combinations require absolute order; and however much this might have been observed (and Xenophon tells us that it was observed, adding that the trireme was crowded with men *σεσαγμένη ἀνθρώπων*) on ordinary occasions; yet, with a shower of darts falling on the men and the waves leaping up against the oars, it must occasionally have been impossible to avoid confusion, and that too at the critical moment.

In conclusion, I will examine one or two of the most notable passages, which present considerable difficulty at first sight.

Xenophon, *H. G.* II. i. 28, where Conon is surprised at Ægos Potamos: the crews, which had dispersed on shore, rush hurriedly to their ships; but the enemy is upon them, before the vessels can be manned; and they have to push off in the following condition: *αἱ μὲν τῶν νεῶν δίκροτοι ἦσαν, αἱ δὲ μονόκροτοι, αἱ δὲ παντελῶς κεναί* (we find elsewhere *δίκροτος* and *διήρης* used as synonyms). It has generally been assumed that this must mean that some of the vessels had only *one* or *two* of their *three banks* of oars manned. But we know, from other sources, that each rower had his proper station at a particular oar; and it is much more likely, in my opinion, that instinct would be supreme in the confusion; so that, as each man hurried up, he would rush to his particular oar (whether his station was fore or aft, below or above), and proceed to cast it loose, without waiting for his comrades of the same bench or (for the sake of argument) "*tier*." I would explain thus: "Some of the ships had but two men to an oar, others but one, &c."

Lucan, *Pharsal.* III. v. 536, foll.:

> "Validasque triremes,
> Quasque quater surgens exstructi remigis ordo
> Commovet, et plures quae mergunt aequore pinus,
> Multiplices cinxere rates: hoc robur aperto
> Oppositum pelago. Lunata fronte recedunt.
> Ordine contentae gemino crevisse Liburnae.
> Celsior at cunctis B·uti praetoria puppis
> Verberibus senis agitur, molemque profundo
> Invehit et summis longe petit aequora remis."

Here we have *biremes*, *triremes*, *quadriremes*, *quinqueremes*, and the *hexeris* of Brutus.—*Exstructi remigis:*—As I have said before, in these huge vessels, the men nearer the upper extremity of the oar must have been placed higher than those nearer to the thole pin; but, if each man had a separate oar, how long and awkward the highest must have been! The *Liburnae*, which were light, swift sailing vessels, are said to have been content "*ordine gemino*"—naturally, as the *Liburnae* did not stand so high out of the water, their oars would be shorter and more easily managed. Whereas the *praetoria puppis*, which towered above all the others (*celsior*, *&c.*), would, necessarily, have longer and heavier oars; hence each was plied by six men. Scaliger's objection, that the words "*summis remis*" suggest that this vessel had other oars nearer to the water.

may be met, I think, with the answer that these oars are not *summi* as compared with others in the same ship, but in comparison with those of the other vessels. Again Bayfius cites passages in which we are told, incidentally, that the *quinqueremes* breasted a rough sea better than the *triremes;* and this could hardly have been the case if their oars, necessarily longer and heavier, had been manned by a single rower.

Æschylus, *Agam.* v. 1618.

σὺ ταῦτα φωνεῖς νερτέρᾳ προσήμενος
κώπῃ κρατούντων τῶν ἐπὶ ζυγῷ δορός;

Here, *οἱ ἐπὶ ζυγῷ* are supposed to be *οἱ ζυγῖται*—and Paley renders "those on the upper benches." But it is more natural to understand here, the officers and fighting men; who occupied a higher position, in both senses, than those who "sat at the oar below." The haughty taunt of Ægisthus is shorn of half its sarcasm, if he merely contrasts himself with fellow workers, who occupied a position but one grade lower than his own.

Aristophanes, *Equites*, v. 545. *Αἴρεσθ' αὐτῷ πολὺ τὸ ῥόθιον, παραπέμψατ' ἐφ' ἕνδεκα κώπαις κ.τ.λ.*

Although this passage does not bear directly upon the subject of my remarks, I cannot help noticing, as I have not seen it elsewhere, a curious explanation which Isaac Voss gives of the phrase *ἐφ' ἕνδεκα κώπαις*: he says that the speed at which a galley was going, was roughly calculated by the number of benches which were passed at a stroke; fast travelling, in his day, was a stroke which drove the galley a distance of seven benches. According to his view, "with an eleven oar stroke," would mean that the distance between eleven benches was passed at each stroke. Scheffer quotes Silius, where a light Liburnian galley is said to have passed more than its own length at each stroke. *Pun.* XIII. v. 240.

"Quanta est vis agili per caerula summa Liburnae,
Quae, pariter quoties revocatae ad pectora tonsae
Percussere fretum, ventis fugit ocior, et se,
Quam longa est, uno remorum praeterit ictu."

Of course, the actual speed would depend upon the time of the stroke. Voss tells us that twelve hundred *stadia* (about 140 miles) a day, was considered very fast sailing for a Liburnian, whereas the modern galleys went much faster—often covering a distance of 1,400 *stadia* in that time.

ASIATIC TRIBES IN NORTH AMERICA.

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In a former paper on the Algonquins I directed attention to the difference between the grammatical forms of that people and those of the nations by which they are surrounded, or whose territory borders on the Algonquin area. I also indicated that the Algonquin dialects exhibit traces of Turanian influence, which I referred to the proximity of tribes speaking languages whose structure is largely Turanian. This Asiatic influence appears, even more strikingly, in the arts and exercises, dress, manners and customs of the Algonquins. The birch-bark canoe and wigwam, the modes of warfare and hunting, the skin dress and lodge, the snowshoe, ornamentation with porcupine quills, the calumet, are not in any sense Polynesian. Neither are they aboriginal, or adaptations made first upon this continent to the necessities of the country. They existed, as in a measure they still exist, in northern Europe and Asia, before the time of Herodotus, when the Scythian took the scalp of his slain enemy. The Malay Algonquin adopted the implements, dress and customs of the people who occupied the country at the period of his immigration; but retained his soft, liquid speech, with much of his oceanic construction of language, and most of the traits of the Polynesian character. His quiet reserve is as unlike the manners of the rude, boisterous and fun-loving Athabascan as is the silent dignity of the Malay compared with the noisy childish ways of the Papuan. By nature indolent and caring little for power obtained by bloodshed, he fell before the restless and warlike Iroquois. That the Algonquins held their own, and did not become incorporated with tribes of Asiatic origin, is doubtless owing to the large numbers that at one period must have established themselves upon this continent. This adaptation of an oceanic population to continental modes of life, with all the differences of climate and productions, and the preservation of their identity for many ages, is one of the most remarkable phenomena known to ethnological science.

Although I must apologize for the scantiness of my materials, I feel that I am in a position to indicate the origin of three important Indian families, with which the Algonquins have long been in contact; these are the Tinneh or Athabascans, the Iroquois, and the Choctaws. The first named are the neighbours of the Algonquins on the north, but appear also as an intrusive people as far south as Mexico. The Iroquois are scattered among the Algonquins; and the Choctaws and Cherokees, who are simply disguised Iroquois, were originally situated to the south of the Algonquin area. The Tinneh family I associate with the Tungusians of Siberia and Northern China; and the Iroquois and Choctaws, with the populations of north-eastern Asia, classed by Dr. Latham as Peninsular Mongolidae. It is to these immigrants that we owe the peculiar features of American Indian life.

The Tinneh are the Chipweyans of Mackenzie, Carver and the older travellers, the Athabascans of many writers, the Montagnais of Father Petitot and others who have copied his statements. In the number of their tribes they exceed those even of the large Algonquin family, and they occupy a similarly extensive area, but one upon which civilization has little encroached. Among the more important tribes may be mentioned the Chipweyans or Athabascans proper, the Coppermines, Beavers, Dogribs, Tacullies, Tlatskanai, Koltshane, Atnah or Nehanni, Sursees, Nagailer, Tenan-Kutchin, Kutcha-Kutchin, Yukon or Ko-Yukon, Digothe or Loucheux, Sicanni, Unakhotana, Kenai or Tehanin-Kutchin, Inkulit, Ugalenzes, Umpquas, Hoopas, Wilacki, Tolewah, Apaches, Navajos, Mescaleros, Pinalenos, Xicarillas. In reference to their habitat I cannot do better or more briefly than by quoting the words of Mr. W. H. Dall in his "Report on the distribution and nomenclature of the Native Tribes of Alaska and the Adjacent Territory." This great family includes a large number of American tribes, extending from near the mouth of the Mackenzie south to the borders of Mexico. The Apaches and Navajos belong to it, and the family seems to intersect the continent of North America in a northerly and southerly direction, principally along the flanks of the Rocky Mountains. The northern tribes of this stock extend nearly to the delta of the Yukon, and reach the sea-coast at Cook's Inlet and the mouth of the Copper River. Eastward they extend to the divide between the watershed of Hudson's Bay and that of Athabasca and the Mackenzie River. The designa-

tion (Tinneh) proposed by Messrs. Ross and Gibbs, has been accepted by most modern ethnologists. The northern Tinneh form their tribal names by affixing to an adjective word or phrase, the word *tinneh* meaning "people," in its modifications of *tinneh*, *tina* or *tena*, or in one group the word *kutchin*, having the same meaning. The last are known as the Kutchin tribes, but so far as our knowledge yet extends are not sufficiently differentiated from the others to require special classification by themselves." Mr. Dall gives in the Appendix to this report a vocabulary of the Yakutats about Mount St. Elias, whom he classifies as Koljush or Thlinkeets, but whose language is plainly Tinneh. They differ also from the Thlinkeets by the absence of the lip-ornament and the totemic system, and by eating the blubber and flesh of the whale, which the Thlinkeets regard as unclean.

The word "Tinneh" in its various forms *dinnie*, *dene*, *dinay*, *toene*, *tana*, *ttyannij*, *tine*, *tineze*, *tingi*, *tenghie*, *tinday*, *tinlay*, &c., answers to the *lenni*, *ilenni*, *renoes*, *ililew*, *irirew*, *inini*, *eyinew* of the Algonquin, and should be a guide more or less to the affiliation of the people so designated. Such a form is not very rare, nor is it, on the other hand, very common. Of similar forms in America, as among the Nootkans, Algonquins and some non-Tinneh Mexican tribes, I need not speak. The Celtic *dyn*, *duine* are nearer than any other known to me, and the Celtic languages in their non-Aryan features, which are few and evidently ingrafted, belong to the Ural-Altaic class. In Africa we find such forms as *tna*, *tkohn*, among Bushmen and Hottentots, with *iden*, *dim*, &c., in the Niger region. The Hebrew *adam* appears not only in the Semitic area, but also among non-Semitic Africans, in the Caucasus, and further east, as a monument, perhaps, of Mahomedan Semitic influence. In Polynesia forms like *tangata*, *tamata* present some resemblance, but I am not aware that those who employ these terms, any more than the people above mentioned, designate themselves by any such name. It is different with the Altaic family with which I have associated the Tinneh. The Tungusians call themselves *Tungus*, *Donki*, and are termed *Tung-chu* by their Chinese neighbours, the former being also in several tribes the words for *man*. Inasmuch as the Mantchu dynasty in China is Tungusian, there is every reason to respect the Chinese appellation. The Loucheux *tenghie*, and the Tenan-Kutchin *tingi*, like the Beaver *tineze*, are our Tungusian *tungus* and *donki*. Similarly the Tungus *akee* and the Mantchu *cheche* are the Umpqua

ekhe, and the Tacully *chaca*, woman. The Tungus *tirgani*, day, is the Koltchane *tiljcan; tog*, fire, the Ugalenze *takak; dzsho*, house, the Kutchin *zeh; okat*, river, the Tacully *okox; chukito*, belly, the Ugalenze *kagott; gal*, hand, the Tlatskanai *kholaa; ogot*, nose, the Navajo *hutchih; amai*, father, the Tlatskanai *mama;* and *anya*, mother, the Kenai *anna*. In the accompanying vocabulary a comparison is instituted between a collection of Tinneh words derived from various sources and part of the material of the Tungusic languages furnished by Klaproth.

The Tinneh languages exhibit their Northern Turanian character in the absence of true gender, and the substitution for it of a distinction between nouns as intelligent or unintelligent, noble or ignoble, animate or inanimate. This it has in common with the Tungus. The formation of the plural by affixing an adverb of quantity marks equally the Tinneh languages and the Mantchu. The adverb of quantity thus employed, which is *lau* in certain tribes, is like the Turkish plural in *ler*. There is the closest affinity between the Tungus and the Tinneh languages in regard to the innumerable modifications of the verb to express variety and quality of action found in each. Both groups agree in prefixing the pronoun to the verb, thus differing from the Ugrian and Turkish order of pronominal affixes. Occasionally, however, the temporal index is infixed between the pronoun and the verbal root in Tinneh, while, as far as known to me, it is final in the Tungusian languages, as it is in several tenses of the Tinneh. In Tungus and Tinneh, equally, the accusatives precede the verb. The formation of the genitive by preposing the noun possessor, followed by the third personal pronoun, to the object possessed, characterizes both families. They agree, also, in employing post positions only instead of prepositions. The Mautchu adjective is generally prefixed to its noun, but in some, at least, of the Tinneh dialects it follows. Yet the possessive adjective precedes as in Matchu. The above mentioned grammatical relationships of the Tinneh and Tungus, although far from exhaustive, are sufficiently important to give weight to any other evidence linguistic or ethnological that may be adduced.

Various writers, generally, however, in seeking to account for the origin of the Esquimaux, have referred to the pressure northwards and eastwards of Tartar tribes in the fourteenth and previous centuries; and, among the nations whom they supposed the Yakuts

and other Tartars to have displaced, enumerate the Tungus. This is exceedingly probable, and so far agrees with the Tinneh traditions reported by Mackenzie and Father Petitot. These state that the enemies of the Tinneh, who were very wicked men, dwelt to the west of their nation; that, fleeing from them, they crossed a shallow sea, passing from island to island in a bitterly cold climate, and at last found the sea to the west of them and their enemies to the east. Such traditions plainly indicate the northern Asiatic origin of the Tinneh, and, together with their vocabulary and grammar, limit them to an original home in the neighborhood of Siberia. Mr. Dall and other observers bear testimony to their love of a gipsy, vagabond life, which Martin Sauer, in his account of Billing's expedition, has similarly remarked upon in speaking of the Tungus. The latter stated in reference to this customary moving continually from place to place that the Tungus did so to avoid the contraction of disagreeable odours; and the traveller Hearne, in his "Voyage to Hudson's Bay," mentions a similar dislike to bad smells among the Tinneh tribes. In regard to personal appearance nothing can be said of stature, for, while some writers describe the Tungus as tall, athletic and straight, others speak of them as generally below the middle size. The same apparently contradictory statements are made regarding the Tinneh, showing that both Tungus and Tinneh present much variety in this physical characteristic, although the writers on both sides are agreed that neither in the one family nor in the other is there any tendency to corpulence. The small eyes, high cheekbones, low forehead and coarse black hair of the Tungus are alluded to by Santini and Sauer, and identical features are ascribed to the Tinneh by Hearne, Mackenzie and later writers. Although both peoples are generally in the habit of depilation, it is not universal among either the Tungus or the Tinneh. Some of the Tungus tribes, such as the Tshapojirs, tat-too their faces after the prevailing Siberian fashion with bars or straight lines on the cheeks and forehead, and so, according to many authorities, do the Chipweyans and other Tinneh tribes.

The Tungus is inclined to be demonstrative, mirth-loving, communicative, and the contrast in this respect between the undignified, fun-making and talkative Athabascan and the reserved, grave and silent Cree, his neighbour, has escaped few travellers in the North-West. The docility of the Tinneh is a frequent subject of favorable

comment; and Martin Sauer in this respect accords the palm to the Tungus over all the Siberian peoples he met with in his journeyings. By this feature the Tinneh are separated from the Tartar Yakuts, in spite of the Yakutats being Tinneh, and from the Peninsular tribes represented by the Koriaks and Ainos. The latter, especially, are fierce, intractable warriors, which the Tinneh are not, for, although cruel enough in their conduct towards the feeble Esquimaux, they stand in wholesome dread of the Algonquin Cree, who, though of a widely different race, reminds them of their ancient foe, the Yakut. Mongolian craft and cunning mark the Athabascan, who, with all his docility, is wanting in the savage nobility, the regard for truth and honor, that characterize equally the Algonquin and the Iroquois. He is in no sense the typical red-man of history and romance, but affords an opportunity for novel portraiture of Indian character to the Coopers and Mayne Reids of the North-West.

In domestic and social relations there is absolute identity of custom among Tungus and Tinneh. Government and laws they have virtually none, and are thus incapable of any combination for purposes of conquest. In this respect, however, the Mantchus, a Tungusic people, present a notable exception. The understanding among them relative to property in game, berries and personal effects coincides on both continents. The marriage ceremony is a simple act of purchase in either case, the only difference being that the modern Tungus having domesticated the reindeer, barters that animal for his wife, while the Athabascan must needs offer some other equivalent. Polygamy characterizes the two peoples, who are equally jealous in regard to their wives. But they agree, also, in the absence of chastity among the unmarried, and in the un-American custom of lending their daughters, sisters and female slaves to those whom they honor with their hospitality. The first wife occupies the highest position among Tungus and Tinneh, and, although the place of the married woman is as in most barbarious nations, one of subjection, a larger share in domestic and even in public counsels is granted her in both nations than is generally accorded to American Indian matrons. In matters of religion there is much resemblance, both families being demonolators and sacrificing to evil spirits, the dog being an object of reverence, and their festivals and religious dances partaking of the same character. They agree in consulting young men who have previously prepared themselves by a process of fasting in the inter-

pretation of dreams, and in a species of divination by means of the shoulder-blades of the deer, a practice common to the Tinneh and Tungus with the Lapps and other northern nations of the eastern hemisphere, but unknown, so far as I am aware, among other American tribes.

One of the most remarkable resemblances between the customs of the two peoples appears in their funeral rites. The Tungus, as reported by Santini and Sauer, place their dead in wooden boxes, which they leave above ground and sometimes suspend to the branches of trees. Mr. Dall, in treating of the Unakhotana and Tehanin Kutchin, uses almost the same language as the Asiatic travellers in referring to the mode of sepulture of these tribes. Abernethy, with Santini and Sauer, inform us that the Tungus bury with their dead all their arms and implements, and that their mourning, which is at first violent, lasts generally for a whole year. Mackenzie, Hearne and Father Petitot bear witness to the similar violence and long duration of mourning for the dead among the Tinneh, and to the burying of all the personal effects of the deceased.

The Tungus live in tents made sometimes of skins, at others of birch-bark, as do the Tinneh, who have separate words to denote an ordinary house of the latter character and a skin-lodge. Both peoples are great fishers, hunters and berry-gatherers, while the Algonquins and other Indian tribes confine their attention largely to hunting. The use of the bow is characteristic of Tungus and Tinneh. More remarkable is the presence in the Tinneh area, as attested in Washington Irving's "Astoria," Pickering's "Races of Man," and Dr. Gibbs' "Report on the Tribes of Western Washington and North-western Oregon," of the corslet of pliable sticks interwoven with grass and sinews, which Abernethy found among the Tungus. It is supposed to be the only kind of defensive armour known in America. The Tungus, in common with other Ural Altaic tribes, use the snowshoe; but I am not able to compare its formation with that of the Tinneh tribes which Mackenzie and Hearne characterize as being of superior workmanship. The birch canoe, generally regarded as peculiarly American, is Tungusian in its origin. "The Tongusi," says an author quoted by Mr. Mackintosh, whose book on "The Discovery of America and the Origin of the North American Indians" was published at Toronto in 1836, "use canoes made of birch-bark, distended over ribs of wood and nicely sewed together.

The Canadian and many other American nations use no other sort of boats. The paddles of the Tongusi are broad at each end; those of the people near Cook's River and of Onalaska are of the same form."

Sauer and Mackenzie refer to the insensibility to cold of the Tungus and Tinneh respectively. The former, referring to the dress of the Tungus, says: "Their winter dress is the skin of the deer or wild sheep, dressed *with the hair on;* a breast-piece of the same which ties round the neck and reaches down to the waist, widening towards the bottom, and neatly ornamented with embroidery and beads; pantaloons of the same materials, which also furnish them with short stockings, and boots of the legs of rein-deer, with the hair outward; a fur cap and gloves. Their summer dress only differs in being simple leather *without the hair.*" Referring to the Chipweyans or Athabascans, Mackenzie writes: "There are no people more attentive to the comforts of their dress, or less anxious respecting its exterior appearance. In the winter it is composed of the skins of deer and their fawns, and dressed as fine as any chamois-leather, *in the hair.* In the summer their apparel is the same, except that it is prepared *without the hair.* Their shoes and leggings are sewed together, the latter reaching upwards to the middle, and being supported by a belt. The shirt or coat, when girded round the waist, reaches to the middle of the thigh, and the mittens are sewed to the sleeves or are suspended by strings from the shoulders. A ruff or tippet surrounds the neck, and the skin of the head of the deer forms a curious kind of cap. A robe made of several deer or fawn skins sewed together covers the whole." The same author, speaking of the Dogribs, refers to the elaborate ornamentation of the breast-piece and other parts of their dress; and other travellers have described it in like terms. Santini dwells upon the fanciful and tasteful designs wrought with coloured percupine quills in which the Tungus indulged, and their coronet or head-band of leather, ornamented with embroidery and feathers. To the latter, Mackenzie makes reference also in connection with the Dogribs; and many writers have celebrated the ingenuity in quill-work of the whole Tinneh family, who were probably the teachers of this art to the populations of North America. Finally, although this is a matter not of dress, but of food, both the Tungus and the Tinneh are in the habit of eating the undigested food, principally lichen, in the stomach of the deer, which they mix with berries and other ingredients, as Sauer and Hearne respectively

testify. Such a collection of parallel facts has rarely been presented for the connection of one or more peoples of unknown derivation, and would be impossible as mere coincidences. The only characteristics in which the Tungus may be said to differ from the Tinneh are the truthfulness of the former and the complaining ways of the latter. But the evidence of Sauer to the first of these is not conclusive as to its characterizing the whole Tungus family,* nor can it be said that all the Tinneh tribes are equally unreliable. In docility the two families agree. The Tungus of Sauer were cheerful, and so are the Tinneh in general, although inveterate grumblers, at least in certain tribes, as may be the case with some of the Tungus were more known concerning them. Certainly, no two families representing the old world and the new present closer affinities in name, vocabulary, grammar, physical appearance, dress, arts, manners and customs than do the Tungus of Asia and the Tinneh of America.

Before dealing with the Iroquois, who should in geographical order next claim our attention, I prefer to take up the origin of the Choctaw-Cherokee family, which shows its Asiatic connections more clearly, and which will tend to illustrate and confirm the Iroquois relationships. The original area of the Cherokee-Choctaw confederacy extended from Tennessee southward to the Gulf of Mexico. The Cherokees and Choctaws are generally regarded as distinct peoples, although their languages have much in common. The tribes included under the generic name Choctaw, are the Choctaws proper, the Chickasaws, Creeks or Muskogees, Hitchitees and Seminoles, all of whom are famous in history. They were originally a warlike, encroaching population, of a proud, fierce spirit, differing alike from the reserve of the Algonquin and the childishness and docility of the Athabascan. The character of the Iroquois is that of the Choctaw, and these are the great warrior tribes of North America who brought into the continent its peculiar arts of warfare as the Tinneh family gave to it its peculiar arts of peace. The Choctaws, we are told by Dr. Latham, Catlin, and others, used to flatten the head, and may thus be supposed to connect with the Salish or Flathead family of Oregon. But for the present we seek to discover their old world relationships rather than those of the new. The northern Asiatic people who flatten the head are the Koriaks, who inhabit the extreme

* Wood, in his "Uncivilized Races," characterizes the Tungus as good-natured, but full of deceit.

west of Siberia to the north of the peninsula of Kamtschatka, to the centre of which certain tribes extend. Their languages are allied with the Kamtchatdale, Corean, Aino, Japanese, and Loochoo, and partake more or less of a Mongolian character, being, however, well differentiated from any Ural-Altaic division such as the Ugrian, Tartar, Mongol or Tungus. It is with these Koriaks that I find good evidence for associating the Cherokee-Choctaw confederacy.

In the first place identity of name, although in itself apt to be fallacious, may, as in the case of the Tungus-Tinneh connection, lead to truth. The Koriaks exist in two great divisions, a northern, known as the Tchuktchi, and a southern, the Koriaks proper or Koraeki. The former call themselves Tshekto, men or people, and they are the original Choctaws; the latter, who bear the name Koraeki, are the parent stock of the Cherokees. This looks so exceedingly plain that the question may be asked why was it not discovered before. The answer seems to be, that investigators have been so long theorizing and refining that they managed to overlook plain facts lying upon the surface. Koriaks in Alaska have been looked for, but Tchuktchis in Tennesee and Mississippi would have been regarded as very much out of place. The Koriaks are of good stature, with features more pleasing and prominent than the Mongol. Dr. Latham mentions "their general resemblance in respect to physical conformation to the American Indians." They are warlike and independent, and have encroached upon the Yukagirs and Kamtchatdales, as the Choctaws and Cherokees did upon the southern tribes of the United States. Abernethy states that among the Koriaks the mothers give, as they imagine, a decorous form to their children when infants by applying three boards, one on the top to give them a flat head, and one on each side to give them a sharp forehead." This is the Choctaw process of which Catlin speaks. Sauer relates that the Tchuktchis had a game resembling "prisoner's bars," and at the same time mentions the facility with which they threw stones from a kind of sling. The game popularly known as Lacrosse, common to the Choctaws and Iroquois, must, I think, be referred to, and I regret that I have no work treating fully of Koriak manners and customs by which this may be confirmed.* The Tchuktchis and the Choctaws are alike fond of such athletic sports as

* A game identical with our American Lacrosse is played in Japan. See Wood's Uncivilized Races.

running and wrestling, and in this respect present a marked contrast to neighbouring Asiatic and American tribes. They are equally noted for manual dexterity and mechanical skill, with capabilities for self improvement, as the present civilization of the Cherokees and Choctaws attests, and as is evident from the fact that the highly civilized Japanese are nearly related to the Koriaks. A Choctaw tradition, reported by Catlin, states, that, a long time ago, the Choctaws "commenced moving from the country where they then lived, which was a great distance to the west of the great river and the mountains of snow, and they were a great many years on their way." It is worthy of note that the Tuhuktukis (? Tchuktchi) are mentioned as members of the Cherokee confederacy.

In treating of the Choctaw language I find it necessary to compare ts dialects with those of the Peninsular family in general, owing to the paucity of my collection of Koriak and Tchuktchi terms, and to the fact stated by Dr. Latham, that of the Peninsular languages the grammatical structure of only one of them, the Japanese, is known. The same writer adds that "the Peninsular languages have a general glossarial connection with each other," and "in the opinion of the present writer, the Peninsular languages agree in the general fact of being more closely akin to those of America than any other." The Choctaw word for man *hatak* is the Japanese *otoko*, and the Muskogee *chauheh* is the Loo Choo *chu*. The Choctaw *tike*, *tekchi* woman is the Loo Choo *tackki*. Boat is *peni* in Choctaw, and *fune* in Japanese; and bone is *foni* in Choctaw and *fone* in Japanese. The two Tchuktchi terms for father, *annaka* and *attaka*, are represented by the Choctaw *unke* and the Cherokee *chatokta*. The Cherokee *agaula* and the Choctaw *kullo*, fish, are equally derived from the Tchuktchi *ikhalik*. The Tchuktchi name for god is *istla* and the Choctaw *hoshtahli*, while the Muskogee god, *efeekeesa*, is not unlike the Japanese *jebisu*. The Tchuktchi *aganak* woman is the Cherokee *ageyung;* the Tchuktchi *unako* to-morrow, the Choctaw *onaha;* the Tchuktchi *nouna*, water, the Cherokee *omma*. But I must refer to the accompanying vocabulary for the lexical evidence thus introduced.

In regard to grammatical forms, absence of gender characterizes the Choctaw and Peninsular languages, and the same may almost be said in regard to number. Case is marked in both groups by post positions. The form of the genitive is worthy of special note. In the case of each the possessor, with an affix originally representing

the third personal pronoun, precedes the object possessed; in other words the Choctaw and Peninsular languages practice the post-position of the nominative. Thus in Japanese "the bone of the man" is rendered

otoko no fone,

and in Choctaw hatak in foni.

Similarly, "the finger of the woman" is in Loo-Choo—

tackki noo eebee,

and in Choctaw tekchi in ibbak-ushi.

These forms, which give us the English, *man's bone, woman's finger*, and in which *in, no, noo* represent the possessive inflection *'s*, together with the close resemblance in the actual words employed, illustrate the nearness of the Choctaw to the Peninsular idiom, and render a reference to Tchuktchi grammar unnecessary. The personal pronouns precede the verbal root in Loo-Choo and Japanese as well as in Choctaw, and the temporal index of the verb is final. For the past tense *ta* is the Japanese and *tee* the Loo-Choo index, while in Choctaw it is *tuk, tok*. The Choctaw futures in *ching, he* and *ashki* are like the Mongol in *ya, ho* and *sogai*. In the formation of the passive the Choctaw sometimes inserts an *l* like the Turkish, but in other cases simply changes the final vowel, as in Japanese. The Choctaw negative, *k* or *ik*, combined with the initial pronoun, is the prefixed Mantchu *ako*. In Choctaw, Japanese and Loo-Choo the accusative precedes the governing verb, and the place of the adjective seems in either case to be sometimes before, at others after the noun it qualifies. According to Santini, the Koriak verb, like the Tungus, is susceptible of all the modifications denoting variety and quality of action which characterize the American families of language. The Choctaws are undoubtedly the Tshekto, and the Cherokees the Koraeki.

A family more important in many respects, at any rate to the Canadian student of American ethnology, is that known as the Wyandot, which, in general terms, includes the Hurons and Iroquois. These fall into two divisions, a northern and a southern, the latter being, in the historical period, natives of North Carolina, and thus in proximity to the Choctaws. The most important of the southern tribes were the Tuscaroras and Nottoways. The northern tribes were, and are still in part, in the neighborhood of the great lakes—Huron, Ontario and Erie. The Huron, or Wyandot confederacy,

embracing many tribes comparatively unknown to fame, occupied the more northern, and the Iroquois or Five Nations, the southern part of the area. In the latter confederacy, said to be from three to five centuries old, were included the Mohawks, whose real name, according to Dr. Oronhyatekha, himself a distinguished Mohawk, is Kanyenkehaka, "the flint people," the Oneidas, Onondagas, Cayugas and Senecas. The Tuscaroras, migrating northward, united with them at a comparatively recent period to form the Six Nations, now found on the Bay of Quinte and on the Grand River. An Iroquois tribe originally inhabited the site of Montreal, and were known as the Hochelagas; and another still exists at Caughnawaga on the opposite side of the St. Lawrence. The Caughnawagas, St. Regis Indians and other scattered tribes, are generally known by the generic name Iroquois. A body of Hurons or Wyandots still exists in the neighbourhood of Quebec, where, in the days of warfare between them and the Iroquois, they sought French protection. Of the great nation that once occupied the extensive Lake Huron country, scattered fragments only remain. Some, with their ancient foes and relatives, the Iroquois, are found in the Western States, but the most important band is that found at Amherstburg on the Detroit River, whose history has been written in a somewhat rambling but amusing fashion by one of their number, Peter Dooyentate Clarke.

A peculiarity of the Wyandot-Iroquois dialects is the absence of labials, *w* being the nearest approach to the sound of these letters. In this they differ not only from the Algonquin tongues but from their related forms of speech, the Choctaw-Cherokee. The Mohawk makes a free use of the letter *r*, which in many cases possesses a certain virile force. This is sometimes replaced by *l* in Oneida, and in Onondaga, Cayuga and Seneca, by a breathing. Thus boy is *raxha* in Mohawk, *laxha* in Oneida, *haksaah* in Onondaga. The Tuscarora forms though differing from those of the five nations, agree with the Mohawk in presenting a recurrence of the harsh *r*, so little known to Algonquin speech. As far as I am able to judge, the affinities of the Wyandot proper or Huron are with the Tuscarora, which, from its resemblance to the Cherokee, I am disposed to regard as the oldest and purest form of the Wyandot-Iroquois language. The resemblance that exists between many words of the Tuscarora and Cherokee has been noted in the Mithridates, and is capable of large illustration. For instance, arrow is *kanah* in Tus-

carora, *gahnee* in Cherokee; dog *cheeth* Tuscarora, *cheer* Nottoway, *keethlah, keira* Cherokee; Fire *ocheeleh* Mohawk, *otcheere* Tuscarora, *cheela, cheera* Cherokee; man *itaatsin* Minekussar, *atseeai* Cherokee; woman *ekening* Tuscarora, *ageyung* Cherokee; boy *doyato* Huron, *atsatsa* Cherokee; child *yetyatsoyuh* Tuscarora, *oostekuh* Cherokee; death *guiheya* Iroquois, *choosa* Cherokee; face *ookahsa* Tuscarora, *issokuh* Cherokee; father *aihtaa* Huron, *tawta* Cherokee; mother *nekets* Tuscarora, *akatchee* Cherokee; good *ayawaste* Huron, *seohstaqua* Cherokee; girl *yaweetseutho* Wyandot, *ayayutsa* Cherokee; mountain *onondes* Seneca, &c., *naune* Cherokee; tongue *honacha* Iroquois, *yahnohgah* Cherokee; water *aouin* Huron, *ohneka* Iroquois, *ommah* Cherokee. The following are a few instances of the agreement of Choctaw and Wyandot-Iroquois words. The Iroquois *entiekeh* and the Choctaw *neetak*, day; the Mohawk *ojistok* and the Choctaw *phitchek*, star; the Iroquois *onotchia* and the Choctaw *noteh*, tooth; the Cayuga *hakeaah* and the Choctaw *ushi*, boy; the Seneca *hanec* and Iroquois *johnika* and the Choctaw *chinkeh, unky*, father; the Iroquois *nenekin* and the Choctaw *nockene*, man; the Iroquois *kninonk* and the Choctaw *kanchi*, to buy, are not accidental coincidences, but indications of that relationship which a similarity of character and modes of life render probable.

A curious instance of the transference of a word from one meaning to another is afforded in the Choctaw numeral three, *tukchina*. Now, there can be no doubt that this is the Mohawk *techini*, the Caughnawaga *tekeni*, the Cayuga and Onondaga *dekenih*, which however denote two, instead of three. That *tukchina* and *techini* are the same word is evident from the fact that eight, which in Choctaw is *untuchina*, is in Mohawk *sa-dekonh*, in Caughnawaga *sa-tekon* and in Onondaga *dekenh*. I am disposed to think that the Choctaw form is the true one, as the relation of eight to three gives five, the unit generally employed in compositions under ten. The Choctaw ten, *pocole*, is the Oneida *oyelih*, the absence of the initial labial being a necessity of Iroquois language.

What the Cherokee-Choctaws are, such in a great measure must be the Wyandot-Iroquois judging from the specimen of lexical or glossarial connection already given. What their relation is to the Peninsular family of Asia may easily be shown by comparison, although in philology it is not always true that languages which resemble the same language resemble one another. There may also

be several degrees of resemblance. In some languages the words are so feeble, consisting largely of vowels, that the comparison of any two such languages in different parts of the world gives but unsatisfactory results, unless some law governing the variation of vowel-sounds could be discovered. In Iroquois, Choctaw, and in the Peninsular tongues words are generally strong, with a good deal of the bold Koriak-Cherokee character and Tchuktchi-Choctaw independence, so that the framer of a comparative vocabulary, into which one of these languages enters, will find little difficulty in deciding questions of likeness. There are, however, two things which render comparison less simple in the case of the Iroquois languages than in that of the Choctaw. The first of these has already been alluded to—it is the absence of labials, and, in this connection the uncertain power of *w* in English and French renderings of Iroquois words. If it were always the equivalent of a labial, as it sometimes undoubtedly is, much of the difficulty would be removed. At times it seems to represent the liquid *m*, which is also a labial. The second hindrance is found in the additions to the original root which appear in the Iroquois as we compare it with the Choctaw and Peninsular languages, and which is evident even in comparing the older with the newer Wyandot forms. The Iroquois word has grown uncomfortably by means of prefix, affix and reduplication of syllables, sometimes apparently for purposes of euphony, at others, it would seem in a retrogade direction to evolve by synthesis a concrete out of a comparatively abstract term. Were I better acquainted with the less known members of the Peninsular family of languages with which the Iroquois stands in the closest relation, I might have to modify this opinion.

I am not at present aware of any Asiatic names with which to associate those of the Wyandot family. The word Wyandot, like Oneida, Onondaga, Nottoway, may relate to the Esquimaux term *innuit* and the Samoied *ennete*, meaning man. In Arrapaho, one of the Algonquin dialects, man is *enanitah*. The Wyandot forms for man are oonquich, ungouh, aingahon, ungue, nenekin, (r)onkwe, (l)onque, hajinah, hauj-eenoh, onnonhoue, aneehhah, nehah, eniha, aineehau, (r)aniha—etschinak, ita-atsin, entequos, agint, (r)atsin, (r)atzin, &c. Still, Esquimaux and Samoied forms appear—the Esquimaux *enuk* and Samoied *nienec*. But the Aino *aino* and the Japanese *hito*, *otoko*, may be found in the second and third groups.

The Wyandot family has undoubtedly miscellaneous Asiatic affinities in point of language. The remarkable term *kanadra*, denoting bread, is the Magyar *kunyer*, just as *wish* (five) is the Esthonian *wiis*. Rain in Mohawk is *ayokeanore*,. a peculiar form, and this is the Turkish *yaghmur*; and the Turkish *besh* (five) is also the Cayuga *wish* and the Mohawk *wisk*. The Magyar *kutya* is the Tuscarora *cheeth* (dog) and the Lapp *oadze* is the Huron *auoitsa* (flesh). The Mohawk negative *yagh* is the Turkish *yok*, and *waktare*, an Iroquois word meaning "to speak," is the Yakut *ittare*. Stone is *odasqua* in Iroquois and *tash* in Turk, and tooth is *otoatseh* in Tuscarora, *dish* in Turk. To hide is *kasetha* in Iroquois and *kistya* in Yakut, and field is *kaheta* in Iroquois and *chodu* in Yakut. The Onondaga word *jolacharota* (light) is the Lapp *jalakas*, with an increment. Two is *ohs* Mohawk, *ausuh* Tuscarora, and *uch* Turk, *ews* Yakut, while seven is *jadah* in Mohawk, Oneida and Onondaga, and *yeddi* in Turk.

It may be asked why, when the Ugrian and Tartar languages relate so closely to the Iroquois by unmistakable roots, I turn aside to the Peninsular. I do so for various reasons: First, because certain peculiarities of Turkish and Ugrian grammar, such as personal and possessive pronominal affixes to verbs and nouns, are wanting in Iroquois. Second—Because the Peninsular languages are at least as near in lexical affinity to the Iroquois as are the Ural-Altaic: and, thirdly, because the Choctaw-Cherokee dialects, which are undoubtedly of Peninsular origin, are too like the Iroquois to admit of separation.

The Koriak origin of the Iroquois is given in the identity of the Koriak war-god, Arioski, with the Iroquois Areskoui. The resemblance of these names has often been noted, but it has been regarded as a coincidence similar to that which exists between them and the Greek Ares, curious, but of no scientific value. Mr. Mackintosh, in the little book to which I have already alluded, draws many parallels between the manners and customs of the Koriaks and the American Indians, several of the latter being Iroquois customs. Unfortunately this industrious author regarded the American aborigines *en masse*, and mixed up Koriaks and Tungus in his comparisons. Still, his facts, to which I cannot now refer, are valuable. Arioski is not the only Iroquois word in Koriak. The Koriak or Tchuktchi *khatkin*, *guetkin* are the Iroquois *hetken*, bad;

agwat is *oohuwa,* boat; *rinaka* and *iegnika* are *ronwaye* and *aqueianha,* boy; *aghynak* is *eghnisera,* day; *nutenut, nuna,* are *ononentsia, neujah,* earth; *atta, annak* and *illiguin* are *ata, hanec* and *lahkeni,* father; *annak* is *yoneks,* fire; *gitkat* is *atchita,* foot; *kaaguk* is *kowa,* great; *nujak* is *onuchquira,* hair; *khigan, kihiguin* are *kiunyage,* heaven, sky; *gailigen* is *kelanquaw,* moon; *anak* is *aneheh,* mother; *ekigin* is *agwaghsene,* mouth; *chynga* is *yuungah,* nose; *kiuk* is *joke, kaihyoehakouh,* river; *anighu* is *ouniyeghte,* snow; *gutuk* is *otoatseh,* tooth; *utut* is *ohotee,* tree; *mok* and *nouna* are *ohneka* and *nekahnoos,* water; *aganak* is *ekening,* woman; *acik* is *osae,* young; *ainhanka* is *eniage, eninya,* finger; *unako* is *eniorhene,* to-morrow; *kanujak* is *kanadzia,* copper; and *kulle* is *oyelih,* ten. In some of these words, the increment of which I have spoken, will be observed. Thus, aghynak becomes eghnis-*era;* nujak is lengthened to onuchqui-*ra,* anighu to ouniyegh-*te;* unako, the Choctaw onaha, to-morrow, takes an interpolated *r,* which is probably a mere strengthening of the vowel *a,* and adds *ne,* eniorhe-*ne.* The strength of the Iroquois words comes out well in the Japanese and Loo-Choo. Thus we have *kuru,* Japanese, *karo* Mohawk, come; *kurrazzee,* Loo-Choo, *arochia,* Huron, hair; *kokurro,* Jap., *hahweriacha,* Iroquois, heart; *atcheeroo,* Loo-Choo, *otorahawte,* Huron, hot; *korossu,* Jap., *kerios,* Iroquois, kill; *sheeroosa,* Loo-Choo, *kearagea,* Mohawk, white; *teeroo,* Loo-Choo, *atere,* Iroquois, basket. Terms for man, woman and child are fairly represented in this group:—*Hito, otoko,* Jap., give *itaatsiu, etschinak, hatgina,* man; *tackki* and *innago,* Loo-Choo, give *otaikai* and *yonkwe,* woman; *kodoma,* Jap., is *kotonia,* and *wocka,* Loo-Choo, *woccanoune,* child. The Ainò, which furnishes in its ethnic term for man, an equivalent to *aineehau, eniha,* in *zia* sister adds the original of the Iroquois *tsiha, akzia.* Its *oondee,* arm, is the Iroquois *aonuntsa; cahani,* boat, is *gahonhwa; kounetsou,* moon, *kanoughquaw* and *eghinda; wakha,* water, *auweah; askippi,* finger, *oosookway;* and *o, yes, io.* The Kamtchatdale is also fairly represented in Iroquois. Its form for axe, *kuasqua,* is the nearest I know to the Iroquois *askwechia; adkang,* bad, is the Iroquois *hetken; ktshidzshi,* brother, finds its analogues in *yatsi, atsiha; koquasitch,* come, in *kats; kossa,* dog, in *cheeth; kwatshquikotsh,* see, in *atkahtos; quaagh,* face, in *ookahsah; chtshitshoo,* girl, in *yaweetseutho, caidaizai; settoo,* hand, in *chotta; kisut,* house, in *ganasote; koschoo,* sister, in *akchiha,* &c. The Iroquois third personal pronoun *ra, re* is the

Japanese *are*, and the Loo-Choo *aree*. The Iroquois numerals are more Ugrian and Tartar than Peninsular, so far, at least, as my vocabularies enable me to judge. The presence of many Ugrian and Tartar words in common Iroquois speech is a phenomenon for which I cannot at present account. The same phenomenon appears in the Quichua of Peru.

The Iroquois grammar might be Mongol or Tungus as well as Japanese or Peninsular. It is neither Ugrian nor Tartar. It marks a distinction between nouns as virile and non-virile, similar to that of the Koriak. It possesses a plural in final *ke*, like the Magyar in *k* and the Mantchu in *sa*. It has also a dual like some of the Ugrian languages. It forms the genitive in the same way as the Ural Altaic and Peninsular languages in general, by preposing the genitive, followed by the third personal pronoun, to the nominative. The pronoun in the accusative, or regimen of the verb, precedes it as in Japanese, Mongol, &c., but this does not seem to be always the case with the accusatives of nouns. Another peculiarity of Iroquois grammar is that the small number of proper adjectives in the language follow the noun they qualify, while, in the Ural-Altaic languages, and sometimes in the Peninsular, they precede. Still the possessive adjectives are preposed as well as the word *akwekon*, all, and similar terms. The personal pronouns precede the verbal root, and the temporal signs follow it, as in Mongol, Tungus and Japanese. The Iroquois also agrees with the Ural-Altaic and Peninsular languages in employing post-positions only. Like the Mantchu, Northern Chinese and Choctaw, the Iroquois possesses the exclusive and inclusive plural of the first personal pronoun. It also has separate terms for elder and younger brother and sister, in common with all the Turanian languages. The Iroquois grammar is thus in its main features Choctaw and Peninsular.

The ball-play or lacrosse of the Iroquois, like that of the Choctaws, must be traceable to an Asiatic region, and may relate to the * well-known game of the Basques in Western Europe. A large family of nations and languages has yet to be recognized, that, with the Ural-Altaic class, shall include the Basque in Europe, the Berber, Haussa and Kashna in Africa, the Tinneh, Iroquois, Choctaw, and, perhaps, the Dacotah and Aztec of North America,

* The Basque game, as I learn from my colleague, Professor Coussirat, who has frequently witnessed it, is all but identical with that of the Iroquois.

and the Aymara and Quichua of the Southern Continent; and, intermediate between the Asiatic and American divisions, the Peninsular languages of Asia will occupy an important position. The Altaic languages least in sympathy with this family are the Mongol, whose affinities are largely Dravidian. At the base of this large family the Accad stands, whose relations are probably more Peninsular than anything else; and next to the Accad in point of antiquity and philological importance is the pre-Aryan Celtic, which lives in the Quichua of to-day, as I showed in a contribution to the Societé Americaine de France, and in a list published by Dr. Hyde Clarke in the Journal of the Anthropological Institute. Dr. Hyde Clarke had long before connected the Accad and the Quichua-Aymara, and had linked the Houssa with the Basque. He has also directed attention to Basque similarities in Japanese and Loo-Choo. Most of the tribes composing this family were known to the ancients as Scythians, so that the ancestors of our modern Iroquois may have over-run Media and plundered the Temple of Venus at Ascalon, tantalized the army of Darius or talked with Herodotus in the Crimea. Types of mankind, in a savage state, do not greatly change, as may be seen by comparing the Tinneh or Algonquin tribes with the Iroquois and Choctaw. Languages long retain their earliest forms, as is apparent in the Japanese *somots* and Loo-Choo *shimutzi*, which are just the old Accadian *sumuk*, *samak*, a book, that were spoken in ancient Babylonia perhaps four thousand years ago. This continent may yet furnish materials in philology and kindred departments to lay side by side with the literary and art treasures of the ancient seats of empire on the Euphrates and Tigris, by which to restore the page of long-forgotten history. At any rate there is a path from the Old World into the New by the Asiatic Continent, as well as by the islands of the sea. Discouragements enough have been placed in the scholar's way by one-sided minds and students of a single language or science. It is time to treat them with the contempt that all narrowness deserves, and to aim at making ethnology more than a statement of unsolved problems.

It would be well for all who hold the essential diversity of American from other grammatical forms, to ponder the statement of one, who, himself no mean philologist, has generally shown little favour to any attempts that have been made to reconcile the Old World and the New in point of language. I allude to M. Lucien

Adam, who, after a comparison of Algonquin, Iroquois, Dacotah, Choctaw, Tinneh, Maya-Quiche, Aztec, Muysca, Carib, Guarani, Quichua and Kiriri grammars, adds this important note: "In fact the preceding languages are all more or less polysynthetic, but this polysynthesis, which essentially consists in suffixing subordinate personal pronouns to the noun, the postposition and the verb, equally characterizes the Semitic languages, the Basque, the Mordwin, the Vogul, and even the Magyar." As far as American philology is concerned the question of the unity of the human race remains where it has been fixed by Revelation. I close this paper with a sentence from Dr. Daniel Wilson's address before the American Association: "The same lines of research (as those which have demonstrated Aryan unity) point hopefully to future disclosures for ourselves, helping us to bridge over the great gulf which separates America from that older historic and prehistoric world; and so to reunite the modern history of this continent with an ancient past."

I.—COMPARATIVE VOCABULARY OF THE TINNEH AND TUNGUS LANGUAGES.

The material of this and the following vocabularies has been derived from English, French and German sources, with variant orthography. I have not thought fit to make any other alteration than that of replacing the German *j* with *y*, as such English vowel sounds as *ah*, *ee* sufficiently attest their origin.

	TINNEH.	TUNGUS.
arm	ola, T. (Tacully)	ngala
axe	taih, K. (Kutchin)	tukka
	shashill, T.	shuko
bad	tschoolta, Kn. (Kenai)	kamult
bear	sus, T.; yass, C. (Chipweyan)	keki, kuti
beard	tarra, D. (Dogrib)	tshurkan
bed	kaatsch, U. (Ugalenze)	sektau
belly	kagoft, U.	chukito
bird	kakashi, Kn.	gasha
	tsoje, Ko. (Koltshane)	doghi
black	tkhlsune, Tlt. (Tlatskanai)	sachalin
blood	sko, T.	shosha
	shtule, Um. Umpqua)	sugal
boat	tsi, T.	djaw
boy	kaha, B. (Beaver)	kuakan
bread	kliuthchu, K.	kiltora
brother	chah, K.; echill, T.	aki
bull	chasska, U.	chjukun
	ahkik, K.	etsche
child	beye, T.	buja, bujadjui
	quelaquis, C.	uli, aljukan
	ischynake, Kn.	kunga
clothes	thuth, C.; togaai, Kn.	tetiga
cold	nikkudh, K.	inginikde
	hungkox, T.	inginishin
	oulecadze, B.	yullishin
come	chatchoo, L. (Loucheux)	tschi
copper	thetsra, K.	tschirit
day	tiljcan, Ko.	tirgani
daughter	nitchit, K.	unadju
deer	batshish, Ko.	buchu
drink	esdan, Mo. (Montagnais)	undau
	chidetleh, L.	koldakoo
ear	xonade, Klt.	schen
	szulu, K.	korot

	Tinneh.	Tungus.
earth	ne, Na. (Navajo); nanee, Um.	na
eat	beha, L.	bishui
eye	eta, Mo.	esha
father	mama, Tlt.	ama
fire	teuck, At. (Atnah); takak, U.	toua, tog
fish	uldiah, C.	olda
	lue, Mo.	ollo
forehead	sekata, Y. (Yukon)	onkoto
girl	getsi, K.	asatkan
	kernihl, Tol. (Tolewah)	ghoorkan
give	hamiltu, C.	omuli
go	antonger, Y.	genigar
good	sutchon, T.	ssain
great	unshaw, C.	ekssham
	choh, K.	choydi
green	dellin, Mo.	tschurin
hand	kholaa, Tlt.; hullah, Na.	gala
	iula, Mo.	nala
head	edzai, D.	udjoo
heaven	jujan, Kn.	njan
house	zeh, K.	dzaho
husband	ahoteey, C.	edee
	etsayoh, B.	eddiu
	deneyu, Mo.	ediu
ice	ttatz, U.	djuko, dschuche
iron	shlestay, T.	sele
knife	teish, T.	utsch
	tlay, L.	sele
leaf	chitun, K.	awdanna
life	anna, T.	inni
lightning	nahtunkun, K.	talkian
lip	edanne, Mo.	aodjun
man	tengi, K.; tingi, Tn. (Tenan-Kutchin); tenghie, L.	tungus, donki
	sykka, U.	chacha
	payyahnay, P. (Pinaleno)	bey
mother	anna, Kn.	enie
	an, Mo.	ani
mountain	schhell, T.	tscholkon
	tauri, Mo.	urra
no	anme maw, B.	umi
nose	neuzeh, At.	nigsha
	huntchu, H. (Hoopah)	onokto
old	saiyidhelkai, K.	sagdi
pipe	tekatski, T.	tagon
rain	naoton, T.; tsin, K.	oodan, uddun
	tchandellez, Mo.	tukdol
red	delicouse, C.	cholachin
river	okox, T.	okat
salt	tedhay, Mo.	tak
see	eshi, Mo.; utschtschillia, U.	itschetschim
serpent	nadudhi, Mo.	nogai
sleep	azut, U.	adjikta
small	astekwoo, Tlt.	adsighe
	nacoutza, Y.	ujuktschukan
son	tsiah, K.	dsui
spoon	schitl, U.	kuili
star	kumshaet, L.	omikta
	klune, Y.; shlum, T.	haulen
stone	tschayer, P.	djollo
sun	chokonoi, Na.; chignonakai, Co. Coppermine.	schigun
	shoonnahaye, M. (Mescalero)	shun
thunder	idi, Mo.	addi
thread	mo, Mo.	umi
tongue	tsoola, T.	tschola
tooth	egho, X. (Xicarilla); shti, Tol.	ikta
wife	sak, T.	ashi
	jarcooey, C.	sarkan
wind	atse, Y.	edyn
wolf	yess, C. T.	gusko
woman	ekhe, Um.; chaca, T.	heghe, cheche
write	edesklis, Mo.	dokli

The Tinneh numerals do not agree with the Tungus, but seem intimately related to those of the Koriaks, Tchuktchis and Kamtchat-

dales. This must be the result of intercourse between the Tinneh and these peoples in an Asiatic home, as the general vocabulary of the Tinneh shows comparatively little likeness to those of the so-called Peninsular family.

	Tinneh.	Peninsular.
1.	tahse, A. (Apache); tashte, Co.; tashayay, M.	dysak, *Kamtchatdale*
	etscha, T.; titskoh, Tol.	ataahek, *Tchuktchi*
	tihlagga, K.; aitschla, Um.; tathlai, Na.	attajlik, T. •
	kisslekka, I. (Ingalik)	
2.	natoke, Tlt.; inteka, I.; nateakcha, At.	nitakaw, *Koriak*
	techa, Kn.; gatte, U.	hyttaka, ytahgau, K.
	nach, H.; nekai, K.; nacheh, Tol.; nakhe, C.	niochtah, K.
	nahke, D.; onghaty, B.	
3.	tokchke, Kn.; toek, W. (Wilacki); taak, Um.	tschok, tsook, Ka.
	tahek, H.; tiik, K.; taakei, At.; tauh, Na.	
	kahyay, M.	ginch, K.
4.	teucheh, Tol.; tuntschik, Um.; teetutye, Si. (Sicanni)	tschak, tschaak, tschaaka, Ka.
	dine, D.; tin, Na.; tang, K.	ishtama, T.
5.	inla, lakken, D.	moulon, myllygen, K.
	swoila, Tol.; schwullak, Um.; chwola, H.	(sombula, sabljak, shumblia, sumula, *Samoied*)
	sesunlase, Mo.; skoulai, T.	sewinlak, T. (6)
6.	coolar, W.; ulkitake, T.	gylkoch, kylkoka, Ka.
7.	tluzuddunkhe, C.	tscholudunug, Ka. (8)
	etsedetsenekai, K.	etachtanu, Ka.
	ookaidingkee, Si.	ahdanuth, etuchtunuk, Ka.
	hoitahee, Um.; tauntee, B.; tsaytch, Tol.	itatyk, Ka.
8.	coostak, W.	tshookotuk, Ka.
	elkedingha, C.	tscholudunug, Ka.
9.	tahgeeahttah, C.	tschuaktuk, Ka.
	coostenekha, W.	tschaaktanak, Ka.

II.—COMPARATIVE VOCABULARY OF THE CHEROKEE-CHOCTAW AND PENINSULAR LANGUAGES.

axe	gahlooyahste, *Cherokee.*	galgate, *Koriak;* algatta, *Tchuktchi.*
bad	ooyohee, "	ashiki, *Japanese.*
	okpulo, *Choctaw;* hooloowako, *Muskogee*	achali, K. (Koriak)
bear	yonung Ch. (Cherokee)	keingin, T. (Tchuktchi)
beard	ahhahnoolunghunge, Ch.	elun, *Kamtschatdale*
belly	ikfuka C. (Choctaw)	fuku, J. (*Japanese*); piigi, Ka. (Kamtschatdale)
	innhalkay M. (Muskogee)	kaltki, Ka.
belt	uskofachi, C.	obee, *Loo-Choo*
bind	takchi, C.	toji, J.
bird	hushi, C.	hotu, L. (Loo-Choo)
black	kungnahgeh, Ch.	kunni, *Aino*
	loosah, C.	luulklek, K.
blood	homma, C.	kehm, A. (Aino)
	chata, M.	ketsu, J.
	issish, C.	chi, L.
boat	peni, C.	fune, J.
body	ahyahlunge, Ch.	gylgin, K.
bone	foni, C.	pone, A.
bow	itchukkatoxy, M.	edzak, Ka.
boy, son	pooskoos, C.	poo, A.; patscha, Ka.
	chahpozhe, M.	tungpoka, *Corean*
	nokkene, C.	iegnika, T.
	ushi, C.	ekik, K.
broad	hoputha, C.	habba, L.
brother	taychokkaduy, M.	otoko-kiyodai, J.; tyga, Ka.
	chotchilchwauh, M.	djalatscha, Ka.
	unggenele, Ch.	eninelan, eninelcha, ninelek, K.
	nocksish, C	eninichse, ninichsi, K.
	imunni, C.	emtschanhi, K.
burn	hukmi, C.	yuku, J.
buy	kanchi, C.	kau, J.
child	hokosy, M.	chigazi, A.
	hopohvyah, M.	bofoo, A.
	pooskoos, C.	wocka, L. (young)
clod	kupussa, C.; kussupe, M.	feesa, L.; tschapchunak, T.

day	neetak, C.	nitchi, L.
death, die	illi, C., ilzah, M.	willlagyn, K.; haiulwa, A.
devil	askina, Ch.	akuma, J.
dog	ophe, C.	stahpu, A.
drink	ishko, C.	igu, A.
ear	istehuchtsko, M.	tschiftuchk, T.
	cheelane, Ch.	welolongen, C.
eat	pa. impa, C.	ippah, imbi, A.
	ahlestahyunghungskaw, Ch.	allotlonim, Ka.
egg	akang, C.	kuga, L.
evening	oosunghe. Ch.	aigomkje, T.
	yhofkosuy, M.	yube, J.
eye	tolltlowah, M.	lilet, K.
	mishkin, C.	manako, J.
far	hopiyi, M.	yempo, J.
father	aki, C.	chichi, J.; isch, K.
	unke, aunkke, C.	una, A.; annaka, T.
	tawta, Ch.	teteoya, J.
	ilhky, M.	illigin, T.
female	tek, C.	tackki, L.
fight	bohli, C.	pillnak, T.; buchi-ai, J.
finger	ibbak-ushi, C.	yubi, J.; eebee, L.
fish	atsatih, Ch.	etschuda, Ka.
	aganla, Ch.; kullo, C.	ikahluk, T.
	nune, C.	ennen, K.
flesh	ahpisochah, M.	tubish, Ka.
fox	choola, C.	tchasalhai, Kr.; gitgalgin, K.
fruit	uni, C.	ewynak, K.
girl, daughter	take, C.	tackki, L.
	chuchhoostee, M.	chtshitshoo, Ka.
go	ahe, C.; aguy, M.	iku, yuka, J.
	foka, C.	apkas, A.
god	hoshtahli, C.	istla, T.
good	chito, C.; heetla, M.	hota *Corean*; kuwodai, J.
goose	shilaklak, C.	lachlach, T.
grass	hasook, C.	kusa, J.; ewuk, T.
great	tlakkeh, M.	lukuklin, K.
	chito, C.	chytschin, Ka.
green	etsahe, Ch.	ichtschitschi, K.; sjiu, A,
	pahuyhlammyomuy, M.	aplela, K.
hail	gahnasookha, Ch.	kannik, T.
hair	gitlung, Ch.	kitigir, K.
	pase, pache, C.	bode, *Corean*; feejee, L. (beard)
	nutakhish, C. (beard)	nujak, T.
head	skoboch, *Chickasaw*	schaba, A.; kobe, J.
	nishkubo, C.	naskok, T.
	ecau, M.	kashko, T.
heart	chunkush, C.	shin, J.
	effaga, M.	sampeh, A.
	oonche, Ch.	minjugu, Ka.
heaven, sky	gullungluddee, Ch.	keilak, T,
hot	ukanawung, Ch.	kikang, Ka.
house	chookka, C.	ke, uchi, J.
ice	okte, C.	tschikutu, T.
life, live	okchaya, C.	kakowa, Ka.
light	egah, Ch.; hiylaguy, M.	choigychei, K.
lightning	anahgahleske, Ch.	kumylgilat, K.
love	immuyuyhluy, M.	okmukulingin, K.
man	hottok, C.	otoko, J.
	nockene, C.	ningen, J.
	chauheh, M.	chu, L.; chujaliutsch, K.
moon	teenœnentoghe, Ch.	tankuk, T.
	halhasie, M.	jailgat, K.
morning	onnihile, C.; sunahlae, Ch.	emukulas, Ka. (unhaiel, *Yukagir*)
mother	iehskie, M.; akachee, Ch.	okkasan, J.
mountain	nunichaha, C.	naju, K.; naigak, T.
mouth	tsiawii, Ch.	zehylda, Ka.
	chaknoh, M.	seklangin, K.
neck	innokewau, M.	ingik, K.
night	ninnok, C.; nennak, M.	nigynok, K.; unjuk, T.
nose	kohyoungsahli, Ch.	kajakan, Ka.
old	suppokne, C.	gepinowli, K.
prince	miko, C.	miko, J.
rain	ema, C.	ame, J.
	omba, C.	apftu, A.

	aski, M.; aguskah, Ch,	azgutsch, Ka.
red	keekahgeh, Ch.	akai, J.
	chahti, M.	kawachtuk, T.
river	hucha, C.	gychi, Ka.
	bok, C.	bez, A.
	equonih Ch.	gojem, K.
run	chuffa, C.	shuppon, J.
	sitkuscha, M.	chikuten, J.
salt	hupi, C.	schipoo, A.
sea	amaquohe, Ch.	umi, J.; mok, imah, T.
	wehuta, *Hitchitee*	atui, A.
sick, sickness	abeka, C.	biyoki, J.
sister	unggedo, Ch.	onna-kiyodai, J.; tschagado, K.
	nocksishtike, C.	najahak, T.
skin	hakschup, C.	kawa, J.
sleep	gahlehah, Ch.	keilkat, K.
	nusi, C.	netsuki, J.
	nogobuscha, M.	soibushi, J. (sleep together)
small	chotgoose, M.	chiisai, J.
snow	ungnawtsi, Ch.	anighu, K.
	tilligue, M.	hlhigwuh, K.
star	owohchikea, *Hitchitee*	hoshi, J.
	phoutchik, C.	foshi, J.
summer	miski, C.	natsu, J.
	kohkee, Ch.	ka, J.; kuiga, T.
	tomepulleh, *Chickasaw*	adomplis, Ka.
sun	neetak-husih, C. (Day-star)	nichi, J. (day) hoshi, J. (star)
	neetahusa, M.	matschak, T.
	kalesta, Ch.	kulleatsch, K.
take	ishi, C.	oku, A.
throat	ahgelega, Ch.	igliak, T.
thunder	hiloha, C.	kyhal, kyigala, kihihelan, K.
	jyrajaa, C.	rai, J. urgirgerkin, T.
to-morrow	onaha, C.	unako, T.
tongue	soolish, C.; istetolahswah, M.	etschilla, K.
tooth	innotay, M.	wuttinka, T.
tree	iti, C.; itta, *Chickasaw*; uhduh, Ch.	utut, K.; uttu, T.; uuda, Ka.
walk	yahkahbuscha, M.	hakobu, J.
water	uckah, C.	waku, A.
	ahmah, Ch.	emuk, T.; mima, K.
white	hatki, M.	haku, J.; attych, Ka.
wolf	yahah, M.	haigugeh, K.
woman	choyo, C.	jo, J.
	ageyung, Ch.	aganak, T.
	tike, tekchi, C.	tackki, L.
1.	humna, M.	onnon, K.
2.	tuklo, C.; toogalo, *Chickasaw*	tzogelsch, Ka. (3)
3.	tsawi, Ch.; totcheh, M.; tukchina, C.	tsook, Ka.
4.	ushta, C.	ishtama, T.
	nunggih, Ch,	nijach, K.
5.	tahlapi, C.	tachlima, T.
6.	hannali, C.	nunmalan, onnamyllangan, K.
7.	untuklo, C.	nitachmallangga, K.
8.	untuchina, C.	tschooktunuk, T.
9	ostabah, M.	stammo, T.
10.	pocole, C.	kulle, T.

III.—COMPARATIVE VOCABULARY OF THE WYANDOT-IROQUOIS AND PENINSULAR LANGUAGES.

above	ebneken, *Iroquois*	uyeni, *Japanese*
arm	onentcha, I.	oondee, *Aino*
axe	askwechia, I.	kvasqua, koshcho, *Kamtchatdale*
	nokeuh, *Tuscarora*	inggako, *Koriak*
	ahdokenh, *Mohawk*	adaganu, K.
basket	atere, I (*Iroquis*) [M. (Mohawk)	teeroo, *Loo-Choo*; zaru, J. (*Japanese*)
bear	oochereuh, T. (*Tuscarora*); ooquharlee,	akliak, *Tchuktchi*
bad	hetken, I.	chaitkin, K. (*Koriak*)
	washuh, T.	wasa, *Loo-Choo* [egchka, T. (*Tchuktchi*)
belly	kwichta, I.	ksuch, Ka. (Kamtchatdale); aktscha-
	unagwenda, M.	nanchiin, T.
below	ehtake, I.	jechtok, T.
belt	ontagwarinchta' I.	ririt, irit, T.
black	hontsi, I.	nudchen, T.
	tetiacalas, O. (*Oneida*)	natchala, T.; kytyhalu, K.

blood	cotnuh, T.; gatkum, N. (*Nottoway*)	ketsu, J.
	hotkwensa, I.; otquechsa, On. (*Onondaga.*	
body	gu-ierongue, oieronta, I.	gilgin, K.; karada, J.
bone	onna, H. (Huron)	hone, J.
	hechtienda, I.; akstiyeh, I.	kotsu, J.
bow	awraw, T.	erit, K.
boy, son	laxha, O.	laki, K.
	ronwaye, M.	rinaka, T.
	haksaah, On.; eawook, S. (*Seneca*)	akek, jakak, K.
brother	ataquen, H.; jattatege, On.	otoko-kiyodai, J.; tyga, Ka
	haenyeha, H.	eninichse, K.
	teetoteken, S.	itschamitugin, T.
	teeahgattahnoonduclih, M.	tschamdakal, K.
	yatsi, H.	ktshidzshi, Ka.
burn	gatchatha, I.	yatta, L.
child	kotonia, I.	kodomo, J.
	cheahhah, H.	chigazi, A. (Aino)
	woccanoune, T.	wocka, *Loo-Choo* (young)
cold	wathorats, I.; turea, H.	kiyetaru, J.
come	karo, M.	kuru, J.
copper	quennies, M.; kanadzia, I.	akagane, J.
day	entiekeh, I.	nitchi, L. (*Loo-Choo*)
	ennisera, I.; eghnisera, M.	nichi, J.; aghynak, T.
	yorhuhuh, T.	halui, K.; hallugg, Ka.
do	konnis, I.	okonai, J.
dog	yunyenoh, H.	inu, J.
	cheeth, T.	getten, T.; sheda, A.
	erhar, M.; cheer, N.; tschierha, On.	atar, chatalan, K.
death, dead	kenha, I.	gang, L.
drink	ichnillkeeuh, M.	igyletsch, Ka.
duck	soluck, M.	galle, K.; galgagalach, T.
ear	ohuchta, On.	tschiftuchk, T.
	suntunke, N.	tschintak, T.
earth	ohetta, I.	ttati, *Corean.*
	onouentsia, I.	nutenut, K.
	uenjah, S.; ahunga, O.	nuna, T.
eat	higuech, I.	ku, J.
	tehatskahons, M.	tekitschgyn, T.
egg	onhonchia, I.	nohk, nuku, A.; nyhach, Ka.
end	koktha, I.	hate, J.
evening	yougarlahsickhah, M.	aigaweroe, K.
	teteinret, H.	aathin, Ka.
eye	acoina, H.	gan, J.
	kaka, S.; okaghha, C. (Cayuga)	shigi, A.; iik, T.
father	ionniha, I.; ihani, C.	una, A.
	aihtaa, H.; ata, T.	atta, T.
	rakeni, M.; lahkeni, O.	illigin, T.
feather	onasa, I.	hannee, L.
field	kaheta, I.	tahata, hatake, J.; getschigyn, K.
fingers	eyingia, H.	aihanka, T.
	sahhugnehlahgheh, M.	tschilgit, K.
fire	ontchichta, I.	undji, A.
	yoneks, T.	annak, eknok, T.
fish	otschionta, On.	etschuda, Ka.
	yeentso, H.	entschudu, Ka.
	kenyuck, S.	annegui, T.
foot	saseeke, N.	shaku, J.
	oosa, T.	assi, J.
	ochsita, On.; achita, H.	gitkat, T.
forehead	akentstara, I.	kytshal, K.
	oyeutsa, H.	kuitschitsch, Ka.
fox	titsho, M.	iuchka, T.; hitschkat, K.
frog	skwarak, I.	gayeru, J.
girl, daughter	kaunuhwukh, T.	ngewek, K.
	kayung, O.	suwingh, Ka.
	ikhehawog, C.; keawook, S.	gufikuku, K.
give	keyahwe, wahetky, I.	katchu, Ka.
go	hugue, I.	yuku, J.
	yehateatyese, M.	utashish, Ka.
god	ocki, H.	egeg, K.
	tezhuskahau, H.	duzdeachtschitsch, Ka.
good	oogenerle, M.; ioyanere, I.	gemelewli, K.
great	kowa, I.	ko, okii, J.; kaaguk, T.
	tatchanawihie, N.	chytschin, Ka.

hair	arochia, H.	lauchshach, K. ; ruh, A.
	ahwerochia, I.	tscheracher, Ka.
	onuchquira, On.	kytyhuir, kitigir, K. ; kar-nu, A.
	ononkia, C.	nujak, T.
hand	osnonsa, I.	soan, C. (Corean)
	chotta, I.	syttu, Ka.
hare	tahhoot-ahnaykuh, M.	whl-huta, K.
he	ra, I.	are, J.
head	noatsheera, H.	kashira, J.
	nontsi, I. ; anoonjee, M.	naskok, T.
heart	hahweriacha, I.	kokoro, J.
heaven, sky	quaker-wutika, N.	goku-raku. J. ; rikita, A. ; kochall, Ka.
	kiunyage, I.	chain, Ka. ; khigau, K.
	garonhiague, I.	cherwol, K.
horn	kanagaa, I.	tscheonok, T.
hot, heat	otarahaute, H.	hoteru, J.
	yoonaurihun, T.	nomling, K.
house	kanosiod, C. ; kanoughsode, M.	kisd, kishit, Ka.
	anonchia, H.	ennit, T.
hunger, hungry	cautsore, O.	katsuyeru, J.
	cadagcariax, O.	shandageri, A.
kill	kerios, I.	koroshi, J.
knife	kainana, C.	ko-katana, J.
life	yonhe, M.	inochi, J.
	konnhe, I.	kyjunilin, T.
lip	hechkwaa, I.	kkovan, Ka.
love	enorongwa, M.; aindoorookwaw, H.	(anurak, *Yukagir*)
male	hatgina, I.	otoko, J.
man	nenekin, I.; aingahon, H.	ningen, J.
	itaatsin, *Minekussar*	chojatschin, T.; hito, J.
	eniha, N. ; aneehah, T,	ainuh, A.
	oonquich, M.	kengitsch, Ka. ; oikyo, A. ; ickkeega, L.
	lookque, O.	luka, T.; elku, Ka.
moon	kanaughkwaw, C.	(kininsha, *Yukagir*); kounetsou, A.
	kelanquaw, M.; karakkwa, I.	gailigen, K.
mother	ena, N ; aneheh, H.; eanuh, T.	aingga, anguan, Ka.
	ikilinoha, M.; ahkenolha, O.	ella, elhi, K. ; illia, Ka.
mountain	kaunatauta, C.	kimita, A.
	onontah, H.; onontes, On.	enshida, namud, Ka.; neit, T.
mouth	chigue, I.	kuchi, J.
	yasook, O	syeksye, saaxxa, Ka.
	sishakaent, C.	sekiangin, K.
	oosharunwah, T.	gikirgin, djekergen, K.
	agwaghsene, M.	ekigin, T.
much	eso, I.; aysoo, M.	osa osa, J
	awquayakoo, M.	oowhoko, L.
nail	ohetta, I.	wegyt, T
	oocheelah, M.	wachelang, K.
name	osenna, I.	ninna, K.
navel	hotchetota, I.	hozo, J.; katkatschik, T.
neck	oneaya, M.	onnajan, K.
night	sonrekka, I.	ukuru, anzkari, A.; unnjuk, T.
	kawwassonneak, O.	kyunnuk, Ka.
	nehsoha, S.	nikita, T.
nose	yaunga, H.	enku, K. ; hana, J.
	oteusag, N.	tatuk, T.; ahdum, idu, A.
	oojyasa, T.	echaech, yachchaya, T.
	kakondah, S.	kaakang, Ka.
	geneuchsa, M.	chyngak, T.
	enuchsakke, C.	enigytam, K.
place	kiterons, I.	kakeru, J.
rain	iokennores, I.	(yagmur, *Turk*)
red	quechtaha, S.	kawachtuk, T.
	guwenta-rogon, I.	nitschel-rachen, K.
	tucotquaurauyuh, T. ; oniquahtala, O	tshatshalo, Ka.
river	kihade, C. ; geihate, On.	kiha, Ka. ; kulgutt, T.
saliva	wtchera, I.	yodare, J.
shoes	onokqua, T.	hunginn, C.
silver	hwichtanoron, I.	elnipel-wychtin, K. [K.
sister	tsiha, I. ; akzia, On. ; auchtchee, T.	ahtschitsch, kutchaan, Ka; tchakyhetch
skin	hoserochia, I.	rus, A.
	hnonk, I.	nakka, T.
sleep	wakitas, I.	kangwitkis, K.
small	ostonha, I.	uitschenan, Ka.

snow, to snow	wakerens, I.	yuki, yukigafuru, J.
	ogera, On.	korjel, Ka.
	onyeiak, S.; ouniyeghte, M.	anighu, T.
speak	atakea, H.	idakuwa, A.
spring (season)	kungweeteh, M	anchtoha, T.
star	ojechsoondan, S.	agajin, Ka.
	ojiahonda, C.	ashangit, Ka.
stomach	utskwena, I.	ikuwan, J.
stone	owrunnay, T.	whraugon, K.
summer	akenha, M.; kayahneh, S.	sakan, A.; kegmu, T.
sun	kelanquaw, M.	galenkuletsch, Ka.
	karakkwa, I.	kulleatsch, Ka.; tirkiti, T.
	ladicha, H.	laatsch, T.
	onteka, I.	matschak, T.
	heetay, T.; aheeta, N.	tida, L.; tyketi, K.
	kachquaw, S.; kaaghkwa, C.	koatsch, Ka.
tongue	ennasa, I.	entsel, Ka.
tooth	onouweelah, C.; onawira, I.	wannalgn, K.
	otoatseh, T.	gutuk, T.
throat	niarigue, I.	reguzy, A.
thunder	kaweras, I.	kyhal, kyigala, ikigigrihan, K.
village	kanata, I.	guina, K.
walk	erai, H.	hiroi, I.
	ahteatyese, M.	ita, J.; atchoong, L.
water	auweah, T.; awwa, N.	wakha, A.
	ohneka, I.; oneegha, *Minekussar*	inh, K.; mok, emak, T.
weep	garkentat, I.	terugatirkin, T.
white	kearagea, M.	sheroosa, L.; shiroi, J.
	kenraken, I.	nilgachen, K.; rata-gaunep, A.
	keaankea, C.	genggahlan, Ka.
winter	koashlakke, O.; kosera, I.	kollealas, Ka.
	oxhey, H.; koosehhea, T.	achsachsaan, K.
wolf	ahquohhoo, M.	aigugeh, chgahuwu, K.
woman	yonkwe, M. O.; ekening, T.	innago, L.; aganak, T.
	otaikai, H.	tackki, L.
write	khiatons, I.	katchoong, L.
year	osera, I.	gytscharudo, Ka.
yellow	hotgikkwarogon, I.	nuutelgrachen, T.
	cheenaguarle, M.	duchl-karallo, Ka.
young	osae, N.	atschik, T.
1.	unji, T.; unti, N.	ingsing, K.
	uskot, M.	dyshak, Ka.
2.	techini, M.	ni-techaw, K.
	nekty, T.	niechtsch, K.
	teghia, O.	ytechgau, K.
3.	shegh, S.; segh, C.; ahseh, M.	tsook, Ka.; giuch, T.
	ahsenh, O.; aushank, H.	sang, L.
4.	kayerih, M.	gyrach, K.
	kayelih, O.	tsagelch, Ka.
	huntak, T.	niyach, ngshakaw, K.
5.	wisk, M., &c.	asheki, A.
7.	tchoatak, On.; tsatak, M.	itatyk, Ka.
8.	nakruh, T.	angrotkin, T.
	tagheto, O.	tshookotuk, Ka.
9.	tutonh, M.; tiohton, *Caughnawaga*.	tschachatonoh, tchauatana, Ka.
	tiohto, C.	tschuaktuk, Ka.
10.	oyelih, O.	kulle, T.

ADDENDUM.

THE DACOTAH FAMILY.

It is only since writing the foregoing article that I have found the relations of this important family. The Dacotah languages differ so widely in their vocabulary, or rather in their vocables, from the Iroquois, that, in spite of grammatical construction, and the equally warlike character of the two people, it was hard to imagine a community of origin. In the labials that are wanting in the Wyandot

dialects, the Dacotah is peculiarly rich. So complete is the compensation made by the Dacotah dialects for Wyandot shortcomings in this respect, that labials utterly unknown to the original root start up everywhere, as terminal, medial, and even initial sounds. On the other hand, the strong Mohawk *r* is almost absent in Dacotah; the Upsarokas, Minetarees and Mandans, who sometimes employ this letter, being very sparing in its use. Nor, can it be said, save as a rare exception, that there is an *l* in Dacotah to atone for the comparative absence of *r*, with which, in the Iroquois dialects, it is at times interchanged. The general vocabulary has miscellaneous Siberian affinities, largely with the Samoied, and many with the Ugrian languages. (I may say that I use the word Ugrian to denote the Finnic-Magyar family of languages as opposed to the Altaic, which includes the Tartar, Mongol and Tungus, since I cannot see the propriety of extending it, as has often been done, to the whole Ural-Altaic division). I was thus upon the point of making the Dacotahs a Samoied colony, and had, indeed, communicated the likelihood of such a relationship to correspondents interested in American philology, when light broke upon the subject in connection with the terminations of verbal forms, which, being followed up by other coincidences, settled the matter in favour of a Peninsular origin for the Dacotahs, as well as for the Iroquois and Choctaws. The Hon. Lewis H. Morgan has shown that the Dacotah and Iroquois dialects are allied, and that the latter separated from the parent stock at a much earlier period than the former.

The Dacotahs, better known as the Sioux, and the Nadowessies of Carver and other older writers, are a warlike, intrusive people, of good stature, and generally pleasing appearance, with capabilities of no mean order, and exhibiting, as in the case of the Mandans, a considerable advance in culture beyond the neighbouring tribes. They occupy a great portion of the centre of the continent, being essentially an inland people like the Wyandots and Choctaws. Their hunting-grounds extend from the Red River to the Saskatchewan southwards to the Arkansas, and are chiefly found between the Mississippi on the east and the Rocky Mountains on the west. They are thus the neighbours of many Algonquin tribes, with which they are more or less intermixed. The principal tribes of this family are the Sioux or Dacotahs proper, the Yanktons, Winnebagoes, Assineboins, whose name is Algonquin, Mandans, Upsarokas or Crows,

Minetarees, Ioways, Osages, Ottoes, Omahas, Quappas, Konzas and Hidatsas. Their warlike and independent character is well known, especially in connection with their recent encounter with the American troops and the subsequent withdrawal of some of them to Canadian territory.

The Dacotah word for man, male, is *wika*, *wicasta*, and this is the Tchuktchi *uika;* while other terms, such as *hihna* and *oeeteka*, relate to the Aino *aino* and the Japanese *otoko*. Similarly, the words for woman, *wingy*, *winnokejah*, *wakka-angka* and *tawiku*, represent the Loo Choo *innago*, the Tchuktchi *aganak*, and the Loo Choo *tackki*. The general lexical resemblances of the Dacotah and Peninsular, within the limits, at least, of my somewhat defective vocabularies, are not by any means so close as between the Choctaw and the Peninsular. Still, there are some striking forms. Such are the Dacotah *echong*, make, and the Loo Choo *oochoong; dowang*, sing, and the Loo Choo *ootayoong; yazang*, sick, and the Loo Choo *yadong; cangte*, heart, and the Japanese *sing*, &c. The Kamtchatdale connects intimately with some of the Dacotah dialects, particularly with the Assineboin. The Dacotah *wahcheesh*, child, is the Kamtchatdale *pahatshitsh; matsi*, knife, is *wattsho; toka*, sevant, is *tshequatsh; isto*, arm, is *settoo; ataki*, white, is *attagho*, &c. The Tchuktchi necessarily is connected; and we have the Dacotah *eeneek*, *eejinggai*, *cingksi*, boy, in the Tchuktchi *iegnika; cang*, day, is *gaunak; nijihah*, hair, is *nujak; nahsso*, head, is *naskok; ecat*, small, is *ekitachtu; neah*, *mini*, water, is, *nouna; tehha*, lake, is *touga; onkahuh*, finger, is *ainhanka*, &c, Of the few Corean words known to me, several answer to the Dacotah equivalents; thus the Dacotah *akhui*, ear, is the Corean *qui; uohta*, good, is *hota; paykee*, hair, is *bode; cezi*, tongue, is *chay;* and *pezi*, grass, is *phee.*

I have mentioned verbal terminations as my guides to the affiliation of the Dacotah languages. In Dacotah a common termination for verbs is that variously rendered *ang*, *ong*, *ung*, as in *yatkang*, eat, *nahong*, hear, *pahmung*, spin, *tongwang*, see, *echong*, make, *manong*, steal. Captain Clifford, in his vocabulary of the LooChoo language appended to Basil Hall's voyage, draws attention to a similar termination of the verb. He says: "I have, throughout the vocabulary considered the termination *oong* to denote the infinitive and have translated it as such, even when the sense points to another word, merely to preserve consistency; there are, however, a few excep-

tions to this, and some of the verbs will be found to terminate in *ang*, *ing*, *awng*, *ong* and *ung*." The Japanese infinitive in *mi*, to which there are many exceptions, does not resemble this termination, but connects with the Turkish infinitive in *mek* and the Magyar in *ni*. Neither does the common LooChoo and Sioux form resemble the Mantchu in *re*, or the Mongol in *hu*. We are thus, I think, justified in holding that the Dacotah verbs *echong*, make, *dowang*, sing, and *yazang*, be sick, are the same words as the LooChoo *oochoong*, *ootayoong* and *yadong*, having meanings identical. But a confirmation of the Peninsular origin of the Dacotahs even more interesting is afforded by a comparison of the Assiniboin infinitive, or at least verbal termination, with that of the Kamschatdale. The Assiniboin verbs in their simplest form end in *atch*, *itch*; thus we have *passnitch*, *tusnitch*, to love, *wunnaeatch*, to go, *eistimmatch*, to sleep, *aatch*, to speak, *wauktaitch*, to kill, *waumnahgatch*, to see, *aingatch*, to sit, *mahnmitch*, to walk, &c. Similarly in Kamtchatdale we meet with *kasichtshitch*, to stand, *koquasitch*, to come, *kashiatsh*, to run, *ktsheemgutsh*, to sing, *kassoogatsh*, to laugh, *koogaatsch*, to cry &c. It is true that the Kamtchatdale *kowisitch*, to go, and *kwatsh-quikotsh*, to see, are unlike the Assiniboin *wunnaeatch* and *waum-nahgatch*, except in their terminations; but, as I have already indicated the connection of the Dacotah and Kamtchatka vocabularies, this is an objection that fuller knowledge of Kamchatdale would probably remove. It was the verbal terminations of Sioux in *ng* and of Assiniboin in *tch* that decided the question in my mind of the Old World relations of the Dacotah family of language and tribes. Those who are better acquainted with the Peninsular languages may be able to account for diversities in the Dacotah dialects by corresponding differences in them. That two such unusual forms as the LooChoo and Kamchatdale should occur in one American family is very strong presumptive evidence in favour of that family's Peninsular derivation.

The grammatical construction of the Dacotah languages may be said, at least, to interpose no obstacle in the way of a Peninsular origin. The absence of true gender, and a distinction between nouns as animates and inanimates; the formation of the genitive by simple prefix to the nominative, with or without the third personal pronoun; the use of pronominal prefixes, and of post positions; the place of the regimen before the governing verb, are all in favour of

such an origin. The post position of the adjective, which my knowledge of the Dacotah dialects does not enable me to say is universal, finds its analogue in some Japanese and Loo Choo forms. The inclusive and exclusive plural belongs to the Siberian area, and is Turanian. The post position of the negative *sni* answers to the post position of *nang* and *nashee* in Loo Choo. And the use of two tenses only, a present-past and a future, reminding the philologist of the Semitic and Celtic languages, presents no barrier to the relationship, inasmuch as the temporal index follows the verbal root, while the pronoun precedes it. It is worthy of note that while there is a general agreement in grammatical forms among the Iroquois, Choctaw and Dacotah languages, they specially coincide in marking the difference between transitive and intransitive verbs by the use of distinct pronominal particles. Judging from the identity in form of the Sioux and Assiniboin verbs to the Loo Choo and Kamtchatdale respectively, I would be inclined to regard the Dacotah family as a far more recent off-shoot from the Peninsular stock than the Iroquois or the Cherokee-Choctaws, a view which is favoured by the geographical position of the several tribes.

The ball play or lacrosse of the Choctaws and Iroquois is practised by the Assiniboins, whose method of boiling by dropping heated stones into a skin substitute for a cauldron, has, according to Catlin, gained them their Cree name of "Stone Indians." Pottery was extensively manufactured by the Mandans; and the large, handsome skin lodges of the whole Dacotah family present a marked contrast to the wigwams of the Tinneh and Algonquin tribes. The Mandan lodges, excavated to a slight distance and covered with earth, with the exception of a hole in the centre, are the same as those of the Koriaks and Tchuktchis.* The lascivious dances of many Dacotah tribes resemble those of the Kamtschatdales. One physical peculiarity of this family is the long hair of the warriors which often sweeps the ground. My limited knowledge of the inhabitants of the Peninsular area does not enable me to say whether this feature characterizes any of its populations. The Sioux have a story of a maiden's leap from a precipice into the water, the "Lover's Leap" of Catlin, which recalls the tradition of the Leucadian Rock and the Hyperborean practice alluded to by many ancient writers. If this be a

* According to Klaproth, the Koriaks call the Tchuktchis Mainetang, which may be the original of the name Mandan.

Koriak tradition, the Leucadian Corax, and Charaxus, the brother of Sappho, may be terms of ethnical significance. I have little doubt that the ancient Koriak habitat and centre of diffusion was the Caucasus, where the Coraxi and Cercetae dwelt. The Assyrian in-inscriptions should shed light upon this important family, which finds such large representation on the North American Continent.

A few of the Dacotah numerals show their Peninsular connection by agreeing with those of the Iroquois and Choctaws. Thus the Dacotah *onje*, *eyungkae*, *yonke*, *wonge*, one, are the Iroquois *anji* and *enskat*; while *amutcat*, another form of the same number, is like the Iroquois *onskat*. The Otto *tekeni*, two, is the Iroquois *techini*. I can hardly think that it is a borrowed word, inasmuch as the Sioux *sahdogang*, eight, is the Iroquois *sahdekonh*, and the relation of two and eight was exhibited in the Choctaw *tukchina* and *untuchina*. The Dácotah *weekeechem*, *wikchemma*, ten, are probably the same as the Iroquois *wasenh*; and *cheehoh*, *kakhoo*, five, agree with the Muskogee *chahgkie*. While a more extensive comparison than the materials at my disposal have enabled me to make would be very desirable, it will, I think, be confessed by competent judges, that for the purposes for which the paper has been written, it is not necessary. It will be a simple matter for other students to follow out the lines of research that I have indicated and in a measure illustrated, and either confirm the conclusions arrived at, or otherwise account for the phenomena on which they are based.

COMPARATIVE VOCABULARY OF THE DACOTAH AND PENINSULAR LANGUAGES.

arm	ada, *Hidatsa*; arda, *Mandan*	ude, yeda, *Japanese*
	isto, *Dacotah*, *Yankton* [(*Dacotah*)	settoo, *Kamtchatdale*
arrow	mahha, M. (*Mandan*); ma, mong, D.	mechim, Ka. (*Kamtchatdale*)
	minja, Os (*Osage*)	machmiuche, K. (*Koriak*)
axe	ashpaw, D.; oceopa, A. (*Assiniboin*)	kvasqua, Ka.; kal-kapak, T. (*Tchuktchi*
	ahana, ongspe, D.	ono, J. (*Japanese*)
bad	schicha, D.; ishia, H. (*Hidatsa*)	ashiki, J.
beard	iki, H.; eshaesha, U. (*Upsaroka*)	hige, J.; uika, T. [piigi, K.
belly	ikpi, D.	fuku, J.; pai, *Corean*; ksucb, Ka.
	chesa, Os.	aksheka, T.
	bare, U.	hara, J.
belt	ipasaki, H.; ipiyaka, D.	obi, J., L. (*Loo-Choo*); tapshi, T.
bind	kashka, D.	kuku-ru, J.
bird	dikkappe, U.	tzkepf, A. (*Aino*)
	tsakaka, H.	tac, C. (*Corean*)
black	chippushaka, U.	nufsunke, K.
	eeokhpazec, D. [*Winnebago*	achkuropeeh, A.
blood	uoai, Y. (*Yankton*); waheehah, W.	auku, T.
	wamee, Om. (Omaha)	kehm, A.
	idi, H.; eda, U.	ketsu, J.
boat	wata, D.	agwat, K.; attuat, hetwutt, Ka.
	mati, H.; maheshe, U.	maachdyhm, Ka.
bone	hidu, H.	kotsu, J.; kutsi, L.; kotham, Ka; ha-
bow	etazeepa, D. [hnopah, M.	edzak, Ka. [tamfn, K.; atitaam, T.
	beerahhah, Min. (*Minetares*); ware-	faru, C. [uika, T.

boy, son	eeneek, W.; eejinggai, Min. eeingai, Ot.	oongua, L.; yeg-
	chahinks, A. [(Otto).	okaijeno-bompo, A.
	disi, H.	doji, J.
	shekanja, Min.	shisong, J.
	weeshinga, Os.	bosang, J.
	cingksi, D.; shinzoshinga, Os.	shoni, shisoku, J.
	meetshingshee, D.	musuko, J.
brother	sonkakoo, D.	tschangkuon, C.; kamgoyak, T.
	boocouppa, U.	yubi, yobu, A.
buffalo	tahtungkah, D.	tschimga, K.
	sha, Os.	shao, C.
	bisha, U.	woooooshe, L.
burn	adahahe, H.	taku, J.; yaddee, L.
	ghu, D.	yaku, J., akka, L.
child	wahcheesh, D.	wocka, L. (young); wasaso, A.
	bakkatte, U.	pahatshitsh, Ka.; bogotschi, A.
	shinga-shinga, Om.	shoni, J.
clothes	sheena, D.	ching, L.; choongay, C.
cold	oisnaitch, A.	koenetsch, Ka.
	tasaka, D.	tschachtschen, K.
	ceereeai, Min.	syrriam, A.
	hootshere, U. [neehee, W.	kiyetarn, J.
	sinnee, D.; snee, Y., Ot., Om., see-	samui, kan, J.; kanjukukok, T.
come	hi, kuwa, D.	ki, ku-ru, J.; kokwasitch, Ka.
day	cang, D.; hangwai, Ot.	gaunak, T.
death, die	tha, D.; tehe, H.	tokok, T.
	carrasha, U.	rai, rairosiwo, A.
do	hidi, H. [hah, W.	itashi, J.
dog	shong, A.; shonka, D. Y.; chonke-	ching, inu, J.
drink	hi, H.	kuiki, Ka.
	smimmik, U.	samgam, K.
	meeneatgauch, A.	migutschi, T.
	heeiatekaupeteka, D. [naughta, Os.	tapatken, K.
ear	neetah, Om.; nottah, Q. (*Quappa*);	tschintak, T.
	akuhi, H.	kui, C.; igiad. Ka.
	lahockee, Min.	ilyud, Ka.; wilugi, K.
earth	mahnah, W. [Om.; mongka, Y.	nunna, T.
	maka, D.; maha, Ot., Os.; moneeka,	mok, C.
eat	yuta, D.; duta, H.	etsyh, Ka.
	bahbooshmekah, U.	ippah, imbi, A.
	utahpee, D.	tabe-rn, J.
enemy	toka, D.	teki, J.
evening	tassetoo, D.	tangkitti, tyngfouti, K.
	ohpai, Min.; appah, U.	yube, J.; aibyngit, T.
eye	esa, U.	iik, T.
	eshtike, D.; ishchuhsuhha, W.	sik, shigi, A.
father	ate, H.; atag, D.; dadai, Om.; atcucu, Y.	atta, attaka, T.
	menoomphe, U.	enpitsch, Ka.
fight	kastaka, D.	tatakau, J. (kogdak *Yukagir*).
finger	onkaha, M.	aihanka, T
	shake, D.; shagah, Os.; shagai, Om.	sokora, C.; keko, gyhgek, Ka.
	buschie, U.	pkotsha, Ka
	napchoopai, Y.; shantee-ichpoo, Min.	jubi, A.; yubi, J.; eebee, L.
fire	pytshi, W.; pechae, I. (*Ioway*); pajah,	apeh, A.; pangitsch, Ka.; fi, L.
	beerais, Min.; wareday, M. [Os.	pol, C.; bryuumchitsch, Ka.
fish	hoashug, D.; haugh, Os.; hohhah, W.;	eo, L.; koki, kuki, C.; giyo, J.
	hoho, Om.; ho, Ot.; huh, Q.	
	poh, M.; boa, Min.; booah, U.	uwo, J.
	hoghang, D.; hohung, Y.	sakana, J.
flesh	cehpi, D.	tubis, Ka.
	tado, Y.; tahyuh, Q.; tatookai, Ot.;	taat, tatchal, Ka.
	tando, D.; tandocah, Os.	
	cuructshittee, Min.	korattal, K.
	chahhah, W.	koki, C.
flower	odakapaki, H.	ibuiki, sipoike, A.
	hka, D. [sih, K. (*Konzas*)	ku, C.
foot	siha, D.; sih, Q.; si, W., Ot., Om., Os;	ashi, shake, J.
forest	ochaw, D.	hayashi, J.; ooda, Ka.
fox	soheeda, D.	tschkuada, Ka
fruit	waskuyeca, D. [hoongshee, D.	kuwashi, J.; isgatesitch, Ka.
girl, daughter	meyakatte, U.; macath, Min.; meets-	math, A.; newekik, T.
	meeyaikanja, Min.	neuweku, T.
	sookmeha, M.	shuguina, Ka.
	eejonggai, On.	ungua, L.; suwing, Ka.

girl, daughter	heenukhahhah, W.	kanaz, A.
	shemashinga, Os.	shinzo, J
give	khu, accuje, D.; ku, H.	qui-ung, L.; katchu, Ka.
go	dah, U.; de, D.	tout, teut, Ka
good	itsicka, U.; tsaki, H.	matschinka, T.
	tonhai, Os.	itainoktok, T.
	uohta, D.	hota, C.
grass	pezi, D.; beka, U.; mika, H.	phee, C.; wuk, wehei, T.
hail	makkoupah, U.	yobu, J. (to hail)
hair	nijihah, Q.; masheah, U.; natoo, Ot.	matihushi, C; nujak, nujet, T.
	arra, Min.	ruh, A.; tseracher, Ka.
hand	shautee, Min. [shagai, Om.	syttu, sotong, Ka.
	sake, D; saki, H.; shagah, D.;	ki, L; chketsch, chkatsch, Ka.
he	na, U.; nee, Min; neeah, W,; ount, M	oan, ouno, unin, K
head	naso, Ot; nahsso, W.; nanthu, I.	nashko, naskok, T.
	pa, D.; pah, Y.; pahhih, Q.	gpa, A.; busi, L
hear	kikua, H.	kiku, J.
heart	nasse, U; nochteh, Q.; natah, Min.	nokguek, nunjugu, Ka.
	cangte, D.	shing, J.
heaven, sky	ammahhe, U.; mahagh, Os.	ame, J.
hot	choustungatch, A	kuinitschkit, K.
	ahre, U.; arraise, Min.	karai, J.
	dsasosh, M.	attisa, L.
	dindita, D.	danki, J.
house	tshe, I.; assua, U.; cheehah, W.	uche, ke, J; zise, A.
	tipi, D.; teepee, Y.; teib, A.	zibu, tschap, tschibi, C.
	ote, M.; ati, H.; tea, D; tshe, I.; attee, Min.; teeah, Os	katchi, L.; yado, taku, J.
I	be, U.; vieh, Q.; veca, Os.	wu, T
ice	cagha, D.	cigu, K.
knife	matsi, Min.; mitsa, U.; mahee, Ot, Om	wattshoo, Ka; majiddi, A.
lake	tehha, W.	to, A.; touga, T.
leaf	ape, wapa, D.	wha, L. (jipan, *Yukagir*)
	moneyahpe, U.	niep, A.
life, live	niya, D.; nee, Os.	inochi, J.
	ti, D; itshasa, U.	itchitchee, L.
light	thieshe, U.; edayhush, M.	atchat, Ka.
	ohjajo, Y.	choigychei, K.
love	wahtscheeng, D.	eiwatschim, K.
	ahmutcheshe, U.	aksmatjen, K.
make	echong, D [Y	oochoong, L.
man	wica, D.; wahsheegae, Ot.; weechasha,	ickkeega, L.; okkai, A.; uika, T.
	wongahah, W.; wineha, A.; neka, Os;	ningen, J.; kenge, Ka.
	mattra, Min [nikkah, Q.	nutaira, K.
	hickechewechasta, D.	oyachutsch, T.
	hihna, D.	ainu, A.
	oeeteka, D.	otoko, J.
	kida, H	hito, J.
moon	hangetu-wi, D (night-sun)	tangkitti, K. (night); fi, hi, J. (sun)
	minnatatche, U.	man-getsu, J. (full-moon)
mother	ina, hung, D.; enaugh, Os.	ainga, T; anguan, Ka.
mountain	khyaykah, D.; haiaca, Y.; ohai, T.	oka, J.; gyeigoi, K. [kagir).
	paha, D.; avocavee, Min.	pehguktsch, Ka; bukkon, K. (pea Yu-
	mahpo, ahmahabbe, U.	fnufa, tenup, K.
mouth	iiptshappa, Min.	jeep, C.
nail	shaka, D; shakahaugh, Os; saki, H.	kugi, J.; kukuh, Ka.
near	askahaah, D.	kakio, T
neck	shuah, U.	kuiich, Ka.
	doti, H.; dote, D.; tashai, Ot.	iityg, T.; hutdehn, K.
	apeeh, Min.	kubi, J., L
night	hangyetu, D.	tyngfouti, K.; unnjuk, T.
	estogr, M.	atziroo, L.
no	honkosha, Os.	uinge, K.
	barnetkah, U.	biinakitlin, Ka.
	ea, D.; eah, A.	iya, J.
pouch	wozuha, D.	foosa, L.
rain	maghazu, D.; mahajon, Y; nezuma, Os.	[ta, T.
	naunshee, Om; neezhuh, W.	muchemuks, K.; neptshuk, imagnach-
	hkahoosh, M.	azgatsch, Ka.
	haunah, U.	ame, J: kantsch, Ka.
	harai, Min. [hecat, U.	furi, J.
red	hishi, H; ishshee, Min; sha, D.; his-	akassa, L.; akai, J.
river	wakpa, D; wacopa, Y. [U.; azi, H.	woyampih, K.
	passahah, M.; watishka, Om.; ahesu,	peth, fez, bez, bezu, A.

robe	mahetoh, M.	makak, T.
run	doozakon, D.	tschasgoa, A.
	akharoosh, Os.	hashira, J.
salt	miniskuya, D.; amahota, H.	mashoo, L.
sea	tehha, tehchuna, W.	ta, C.; atui, aducka, A.
servant	toka, D.	tshequatsh, Ka.
sew	kikaki, H.	kuke-ru, J.
shoe	hangpa, D.; honpeh, Q.	hunginn, C.; angesuf, K.
	opah, Min.; hupa, H.	sabock, L.
shoulder	idaspa, H.	tapsut, tapfka, A.; tschilpit, T.
	hiyete, D.	kutta, L.; kata, J.
	amdo, D.	oondee, A. (arm).
sick	yazang, D.	yadong, L.
sing	dowang, D.	utau, J.; ootayoong, L.
sister	wetonga, Os.	ichtum, Ka.
	itakisa, H.	tschakyhetsch, K.
sit	aingatch, A.	eeoong, L. [kotschi, C.
skin	uka, koku, D.; aduaka, K.	ka, L.; kawa, J.; kooogh, Ka.;
sleep	ishtingma, D.	tungykushih, Ka.
	mughumme, U.	moguru, A.; miilchamik, K.
	eistimmatch, A.	miichateu, T.
small	tscheestin, tonana, D.	takine, takoni, A.; uitschenan, Ka.
	ecat, U. [Min.; wahhah, W.	ekitachtu, T.
snow	beah, U.; pau, Os.; pah, Ot.; mahpai,	upas, A.; pangopag, K.
speak	ide, H.	idakuwa, A.
	ia, D.	ii, iu, J.
star	wickangpi, D.	ashangit, Ka.
	peekahhai, Ot.	fosi, L.
	ikaka, M.; icka, H.; eekah, Min.	hoshi, J.
steal	ki, D.	ikka, A.
stone	eeyong, Y.	uigum, T.
	eengro, Ot.	whraugon, K.
storm	tattasuggy, Os.	techtok, T.; tschitchutscha, Ka.
sun	meencajai, On.; menahkah, M.	matschak, T.
	wee, D.; pee, Ot.; weehah, W.	fi, J.
sword	magasagye, D.	magiddee, A.
tail	tsita, H	dzoo, L.
take	ichu, eyaku, D.	eechoong, L.; uke-ru, J.; uhk, oku, A.
they	eonah, M.	oanas, K.
think	echin, D.	shiang, kangaye, J.
thou	de, U.; deeah, Os.; dieh, Q. [ne, M.	tu, Ka.
	nish, D; nehe, Min.; ney, W.; nea, A.;	eanny, A.; nanji, J.
thunder	waikeeang, D	yegilkegie, T.
to-morrow	hayahkaytseehah, D	haiedsai, C.
tongue	dezi, H.; tshedzhi, D.: theysi, Min.; dehzeehah, W.; dehzeh, Q.	dytschil, Ka.
tooth	hi, D., H.; he, I, W., Ot; hih, K.; hee, Y.; ea, U.; ii, Min.	ha, J., L.; ji, C.
tree	nahnah, W.	nan, C.; nih, A.
village	otoe, D.	atanym, Ka
	ameteh, Min.	machi, J.
warrior	ahkitshutah, D.	shisotsu, J. (soldier)
	ankedaugh, Os.	gunsotsu, J. (soldier)
	nassa-battsats, U.	bushi, J. (soldier)
wash	yuzaza, D.	yusugu, J.
water	nih, Q.; neah, Os.; ninah, W.	inh, K.; nouna, T.
	mini, D.; meenee, Y.; minne, U.	nouna, mok, T.; mimel, K.
	passahah, M.	peh, A.
	midi, H.	mese, L.
we	bero, U	warera, J.; muru, K.
	onkia, D.; ungeaip, A.; unguar, Os.	wankuta, T.
weep	cheya, D.	kia, T.; tschisgoa, A.
white	ataki, H.; hoteechkee, Min.	attych, Ka.
	sang, D [chose, U.	chein, C.
	ska, D, Ot., Om.; skah, W., Q., Os.;	haku, J.
wife	moorse, M.	maroo, A.
	moah, U.; mega, I.	mazy, A.
wind	hootsee, U. [mia, H.	kyteg, K.; kyttych, tschichutsha, Ka.
woman	meha, M.; meyakatte, U; meeyai, Min;	math, A.
	wingy, winnokeja, D.; nogahah, W.	innago, L.; mennokoosi, A.
	wakka-angka, D.	aganak, T.
	tawicu, D.	tackki, L.
	unah, D.; euauh, Os.	newem, T.
wood	tschang, D.	tschitschini, A.
	money, U.	nammo, C.

write	akakashi, H.	kaki, J.
yellow	tsidi, H.	dsadsal, Ka.
yesterday	tanneehah, D.	cheenoo, L.
you	dero, U.	turi, T.
1.	duetsa, H.	tizi, L.; dysak, Ka.
	wajitah, D.	hitotsu, J.
	jungihah, W.; eyunkae, I.; onje, D.	ahnehn, ingsing, inshingyan, K.
2.	dopa, H.	tupu, C; tup, A.
	nopa, D.; noopah, Min; nopi, W.	yhnap, inipf, A. (4)
	noue, Ot.; nowae, I.	ni, J.
	tekeni, Ot.	nitakaw, K.
3.	rabeenee, Om.; laubenah, Os.	liep, raph, A.
	tana, Ot.; tanye, I.; tahni, W.	sang, L.; san, J.
4.	topa, H., D.; topah, Min., Y.; toba, Om.; tobah, Os.	tupu, C.; tup, A. (2)
	tome, A.	ishtama, T.
	tuah, Q.; toua, Ot.	tsaak, Ka.
5.	satsch, W.; sattou, Q.; sahtah, K; sahtsha, Min.; thata, I.	itsutsu, J.
	kibu, H.; kakhoo, M.; cheehoh, Min.	asheak, A.; goo, L.; go, J.
6.	ahkewe, H; shaque, Ot.; kohui, W.	iishu, C.
	akama, H.; kemah, M.; acamai, Min.; ahcamacat, U.	ihguaen, ywam, A.
	schappeh, Q.; shappeh, K.; shapah, Os.	juwambe, A.
7.	shahco, D.; shakoee, Y.; shagoa, A.; shako, W.	iikii, C.; shichi, J.
	painumbe, Om.; panompah, Os.; pennapah, Q.	aruwambi, A.
8.	dopapi, H.; keia-tobaugh, Os.	duhpyhs, tubishambi, A.
	pehdaghenih, Q.	pigayuk, T.
	tatucka, M.	tschookotuk, Ka.; yatsu, hatchi, J.
	shahendohen, D.; shakundohu, Y.	tschonutonu, Ka.
	kraerapano, I.; kraerabane, Ot.; krairabaini, Om.	
	perabine, Om. (rabeenee = 3). 5+3.	raph, A. (3).
	schunkkah, Q.; shanke, Ot.; shonka, Om.; shankah, Os	chonatschinki, K.
	nowassapai, Min; napchingwangka, D.	sybnahpyhs, sincsambi, sinobsam, A.
	nuhpeetchewunkuh, Y.	
	mahpa, M. 5+4	yhnap, A. (4).
10.	wiket-shimani, D.; weekchee-minuh, Y.	min-gitke, K.; tschom-chotako, Ka.

AN ANCIENT HAUNT OF

THE CERVUS MEGACEROS:

OR, GREAT IRISH DEER.

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The following notes of a tourist's observations in a brief visit to a locality of great interest alike to the palæontologist and the archæologist, were originally prepared with no further object in view than the contribution of a paper to be read at one of the evening meetings of the Canadian Institute, in the winter following the Irish explorations to which they refer.

The reconstruction of the geography of the Palæolithic Age, and the re-animating its haunts with the extinct mammalia known to us now only by their fossil remains, furnish materials for a romance of science more fascinating to the thoughtful student than all the fanciful creations of fiction. The geologist speaks of that time as recent when the temperature of southern France was such as to admit of the reindeer and the musk-ox, or sheep, haunting the low grounds along the skirts of the Pyrenees. But the term *recent* is used not in a historical, but a geological sense; and is employed in the full recognition of the evidence of enormous revolutions, by which changes have been wrought, the results of which are now seen in the climate, the physical geography, the fauna and flora of modern Europe. Nor have these revolutions been limited to the Eastern Hemisphere; though some of the climatic phenomena of the North American continent still perpetuate characteristics that help us in the interpretation of the strange disclosure of Europe's pleistocene era. Within the preceding geological age the whole northern hemisphere experienced an enormous climatic change, which attained its maximum in the glacial period. Far to the south of the British

Islands Europe presented a condition similar to that of Greenland at the present time; and during the prevalence of this period of extreme cold the glacial drift, boulder clay, and stratified sands and gravels, were deposited over the whole of Northern Europe, and over North America, as far south as the 39th parallel, during prolonged submergence under an arctic sea. Then followed the changes of that subsequent period, during which the physical geography acquired its latest development, and the present continents gradually assumed the characteristics fitting them for existing conditions of life.

Of nearly a hundred species of mammals recognized in the post-glacial deposits of Europe, fifty-seven still occupy the same localities; whilst others, such as the reindeer and the musk-sheep have withdrawn to northerly areas. A continuous chain of life, however, is indicated by the prolongation of about twelve pliocene species into the post-glacial fauna of Great Britain. But, along with those, numerous new species appear; and changes of an altogether novel character are inaugurated by the presence among them of man.

The revolution wrought in physical geography, in climate, and in all the accompanying conditions of life, during the pleistocene age are most clearly illustrated by the character and distribution of the mammalia, of which fifty-three species are represented in the remains found in the gravels and cave deposits. The *Elephas primigenius*, or mammoth, common both to Europe and America, has become extinct in the old world, subsequent to the advent of man. It is still an open question whether in the new world man coexisted with the mastodon; but in the eastern hemisphere at least, more than one species of proboscidian abounded, and in vast herds overspread the northern plains of Europe and Asia. Along with those there were three or four species of rhinoceros, a large hippopotamus, and other forms of animal life pointing to a condition of things widely differing from anything known within the historic period. The herbivora included both deer and oxen, some of which still survive in more limited northern areas; and those, along with the mammoth, woolly rhinoceros, Irish elk, and reindeer, were preyed upon by numerous carnivora, including the extinct cave lion and great cave bear, the *ursus ferox*, or grizzly bear,—now the strongest and most ferocious of all the carnivora of the American continent,—and the cave hyæna, which has still its living representatives in South Africa.

In the variations of temperature which marked the retrocession of the expiring glacial influences in central Europe, throughout the region extending between the Alps and the mountain ranges of Scotland and Wales, the winter resembled that which even now prevails on the North American continent, in latitudes in which the moose, the wapiti, and the grizzly bear, freely range over the same areas where during a brief summer of intense heat enormous herds of buffalo annually migrate from the south. A similar alternation of seasons within the European glacial period can alone account for the presence, alongside of an arctic fauna, of animals such as the hippopotamus and the hyæna, known only throughout the historical period as natives of the tropics. The range of temperature of Canadian seasons admits of the Arctic skua-gull, the snow-goose, the Lapland bunting, and the like northern visitors, meeting the king-bird, the humming-bird, and other wanderers from the gulf of Mexico.

Such conditions of climate may account for the recovery of the remains of the reindeer and the hippopotamus in the same drift and cave-deposits of Europe's glacial period. The woolly mammoth and rhinoceros, the musk-sheep, reindeer, and other arctic fauna, may be presumed to have annually retreated from the summer heats, and given place to those animals, the living representatives of which are now found only in tropical Africa. No class of evidence is better calculated to throw light on some of the obscure questions relative to primeval man, than that which exhibits him associated with the long displaced or extinct mammals of that transitional period. Man, it is no longer doubted, was contemporaneous with the mammoth before its disappearance from southern France; and occupied the cave-dwellings in the upper valleys of the Garonne, while the reindeer still abounded there. In fact, the palæolithic hunter of central Europe, and the extinct carnivora of its caves, alike preyed upon the numerous herbivora that then roamed over fertile plains and valleys reaching uninterruptedly, northward and westward, beyond the English Channel and the Irish Sea; just as the Buffalo—now hastening to extinction,—still ranges over the vast prairies of the North American continent.

Among the fauna of this transitional period in Europe's prehistoric era, one animal, the magnificent deer, known as the *Cervus megaceros*, the *Megaceros Hibernicus*, or Great Irish Elk, occupies in some respects a unique position, and specially invites study. In

its limited endurance as a species it contrasts with the reindeer, along side of the fossil remains of which its horns and bones repeatedly occur; and its circumscribed area gives a peculiar interest to any indications of its co-existence with man. The evidence furnished by the abundance of its remains in certain localities tends to suggest the idea that, at a time when the British Islands were only the more elevated portions of the extended continent of Europe,—which then included in one continuous tract the English Channel, the German Ocean, and the Irish Sea, with a prolongation westward, embracing the Atlantic plateau now submerged to the extent of about one hundred fathoms:—the favourite haunts of the *Cervus megaceros* were in plains and fertile valleys which, throughout the historic period have been mostly buried under the sea.

In the ingenious speculations of the late Professor Edward Forbes on the migrations of plants and animals to their later insular habitats, he assumed a land passage to Ireland, consisting of the upraised marine drift which had been deposited on the bottom of the glacial sea. Over this he specially noted the presence of numerous remains of the fossil elk in the fresh water marl of his own native Isle of Man. In Scotland, on the contrary, where the reindeer existed apparently from the time when it was the contemporary of the mammoth, to a period, historically speaking, recent, authenticated examples of the Cervus megaceros are extremely rare; whereas its designation alike as the *megaceros Hibernicus*, and Irish elk, is based on the occurrence of its skeletons more frequently in Ireland than elsewhere. It has indeed been assumed that there now lie submerged beneath the Irish Sea, the once fertile plains which, towards the close of its existence, constituted the favourite haunt of this magnificent fossil deer.

It is not until the newer pliocene period is reached that the palæontologist encounters the amply developed horns of the gigantic bisons and uri; and that a corresponding size characterises for the first time the antlers of the *Cervus Sedgwickii*, the *Cervus dicranios*, and of the *Cervus megaceros*, pre-eminently noticeable for the enormous dimensions of its spreading antlers. Along with the remains of the latter, or in corresponding postpliocene deposits, those of the reindeer, which still survives both in Northern Europe and in America, are also found, at times in considerable abundance.

At the meeting of the British Association, at Dublin, in 1878, an intelligent local naturalist, Mr. Richard J. Moss, of the Royal

Dublin Society, took advantage of one of the excursions organized for the purpose of visiting the special attractions of the neighbourhood, to invite a party to explore an ancient habitat of the Irish fossil deer, at the Ballybetagh Bog, in the parish of Kilternan, about fourteen miles south of Dublin. The encouragement to research was great, for on two previous occasions the bog had disclosed numerous remains of the *Cervus megaceros*, and during the earlier excavations a fine specimen of the horns of the reindeer, now preserved in the Museum of the Royal Dublin Society, was also found.

Excavations made preparatry to the arrival of the excursionists revealed enough to furnish ample encouragement for further exploration. Saturday (August 17th) was devoted to a tentative examination, with disclosures that abundantly encouraged renewed research; and on the following Monday a small party revisited the spot, under the efficient guidance of Mr. R. J. Moss, and his brother, Dr. Edward L. Moss, R. N., who most liberally undertook the entire charge of the exploration. The results of this renewed investigation of the ancient lacustrine depository of the remains of the fossil deer, though necessarily limited to the labours of a couple of days, proved highly satisfactory; and prepared the way for a systematic exploration of the site at a later date. Meanwhile a brief notice of the subject may possess some interest for others besides those who shared in the exciting operations of a busy but most pleasant holiday.

Ballybetagh Bog lies at the bottom of a glen about 600 feet above the sea, with hills of slight elevation on either side. Here some forty years ago, in making a cutting through the bog for the purpose of turning the water of a spring, known as the White Well, into a stream that flows through Kilternan, the first discovery of the remains of the fossil deer was made; but as the excavations were then carried on with no scientific object in view the chief value resulting from them was the demonstration of the existence there of abundant remains of the great extinct deer.

In 1875, attention was anew directed to the locality; Professor A. Leith Adams and Mr. R. J. Moss visited Ballybetagh Bog, and the latter gentleman undertook a systematic investigation, in concert with Dr. Carte, of the Dublin Society. No record had been preserved of the precise spot where the previous remains had been found, and considerable labour and research had to be expended before the proper site for renewed exploration could be determined.

An account of this exploration was contributed by Mr. Moss to the Royal Irish Academy in which he thus describes the formation under which the fossil remains lay: "The first foot of material removed consisted of peat; under this there was a stratum of sand of an average depth of about two feet. The sand lay upon a brown coloured clay which extended for about two feet, and lay upon a bed of granite boulders. The spaces between the lower parts of the boulders were filled with a fine bluish-grey clay." Here amongst the boulders, and surrounded with the brown clay, nineteen skulls, with many broken pieces of horn and bones were found; and the result in all was the recovery of thirty-six skulls with antlers more or less imperfect, mostly belonging to young deer, along with detached horns and bones, representing in all about fifty individuals of the Cervus megaceros. Among the specimens recovered at the earlier date about thirty individuals of the same gigantic fossil deer had been represented; although both explorations involved only a very partial examination of this remarkably rich lacustrine depository. But the result of Mr. Moss' careful investigation was to determine the precise locality where research might be renewed to like advantage at any future time; and here it was accordingly that a party of members of the British Association were invited to join him in hunting the Irish elk in its ancient habitat among the Wicklow meres.

The scene of this interesting exploration is the site of an ancient tarn, where for ages the moss has been accumulating, till a peat formation of varying thickness overlies a sandy clay intermingled with forms of vegetable matter, and at times with fallen trunks of trees. The whole rests on a bed of clay interspersed with granite boulders, as already described. Among these, but not below them, the bones of the fossil elk occur. But before describing the incidents of the recent exploration, it may be well to make some general reference to the gigantic deer once so abundant in the range of mountains which extend there in a north-westerly direction from the south coast of Dublin Bay, and to the general bearing of the evidence as to the probability of its co-existence with man.

An examination of the detritus and included fossils, the accumulations of fossiliferous caves, and the disclosures of peatmosses, shows that when the earliest ascertained colonists entered on the occupation of the British Islands—whether then insular or continental,—the low

grounds were extensively traversed by a net-work of lakes, and the surrounding country was covered with forest, and overrun by animals known to us now chiefly by the researches of the palæontologist. But also it is among the glimpses which that prolonged transitional period furnishes, that we catch, towards its prehistoric close, evidence not only of the presence of man, but of the introduction of the domesticated animals of Europe. Among its fossil mammalia the true *Cervidæ*, to which the Irish elk belongs, appear to be, geologically speaking, of recent origin. No remains of extinct genera of the deer family thus far discovered in either hemisphere have been found to extend farther back than the upper miocene; and Mr. A. Russel Wallace recognises the whole family as an Old World group which passed first to North America, and subsequently to the Southern continent. The remains of many extinct species belonging to existing genera occur in the post-pliocene and recent deposits both of Europe and America; but no representative of the deer family has thus far been found in South Africa or Australia.

Of the numerous ascertained fossil deer many forms are known only by fragmentary remains; but few great collections of Natural History fail to possess a well preserved skeleton of the Irish elk. Strictly speaking the *Cervus megaceros* is not a true elk, like the living Moose (*Alces palmatus*). It takes its place intermediately between the Reindeer and the Fallow deer (*Dama vulgaris*), and has its living analogues in the European Red Deer (*Cervus elaphus*), and the Wapiti (*Cervus Canadensis*) of the American Continent. The abundance of its remains in some localities, as in the Ballybetagh Bog, their high state of preservation, and their position generally in bogs and lacustrine deposits, overlaid by bog oak and other remains of the latest forests; and at times by actual evidences of human art: all tend to suggest the idea of this gigantic deer having co-existed with man. It was contemporaneous, not only with the mammoth, the woolly rhinoceros, and other extinct European mammalia of a like unfamiliar type, but also with an important group of wild animals which not only survived into that transitional period in which the geologist and the archæologist meet on common ground; but some of which have still their living representatives. Of the former the gigantic Urus (*Bos primigenius*) is the most notable, with its recognized relationship to the larger domesticated cattle of modern Europe. Of the latter the most interesting is the Reindeer.

It bears a near affinity to the Irish elk; they co-existed under similar circumstances, and even at times in the same localities. All three were contemporaneous with the *Ursus spelæus*, the *Felis spelæa*, and other great post-pliocene carnivora; and their remains abound in the ancient cavern haunts of those extinct beasts of prey.

The cave-bear and the Irish elk appear to have been limited to a temperate range, and have both become extinct; and the remains of the latter occur in such abundance in recent deposits that there is a strong temptation to assume the occurrence of some sudden change, climatal or otherwise, which abruptly exterminated this great fossil deer. The Urus and the Reindeer were both in existence in Britain within historic times; whereas the evidence thus far adduced in proof of the co-existence there of the fossil elk with man, pertains exclusively to the palæolithic period; and in so far as Ireland is concerned, where its remains occur in greatest abundance, the conviction is reluctantly forced on us that the great Irish deer had finally disappeared from its fauna before man made his appearance there. This, however, as will be shown, is not an opinion even now universally accepted, either by archæologists or geologists.

In the post-pliocene age the cave lions, bears, and hyænas, of Germany, France, and the British Isles, preyed on the Irish elk, along with the reindeer, mammoth, wooly rhinoceros, the fossil horse and ox; and the bones of all of them occur among the cave deposits in which traces of primitive art reveal the early presence of man. Professor Boyd Dawkins in his record of researches in the Somerset caves, in 1862-3, mentions the remains of the Irish Elk as 35 in number, where those of the Mammoth, the Reindeer and the Bison numbered 30 each, the Rhinoceros 233, the Horse 401, and the cave Hyæna 467; while thirty-five implements or other evidences of human art suggested the contemporaneous presence of man. Remains of the Megaceros have in like manner been identified in the Devonshire Caves; and especially in Kent's Hole Cave in the same strata with flint and bone implements. Its bones are included among the specified contents of the famous sepulchral cave of Aurignac, at the northern foot of the Pyrenees; and its remains have been recognized in seventeen different cave deposits to the north of the Alps; in eleven of which there are indications of the presence of palæolithic man.

So far as evidence thus far points no traces of human art suggest the presence of man either in Scotland or in Ireland, at the period of palæolithic art, so abundantly illustrated in the contents of the caves and river gravels of southern England. But the Irish elk is not only the latest among the extinct mammalia of Europe's palæolithic period; it is recognized as surviving into its neolithic period. Its remains occur in the caves of the reindeer period in southern France, as in those of Laugerie Basse and Moustier; and artificially worked and carved bones of the reindeer have been recognized in more than one of the Swiss caves. Their presence has excited special attention in that of L'Echelle, between the great and little Salève, from its close vicinity to Geneva, owing to the proof it affords of the coexistence of man and the reindeer within the area which subsequently formed the hunting ground of the lake-dwellers of Switzerland; whilst no trace of either the megaceros or the reindeer has been found among their abundant illustrations of the arts alike of the neolithic, and of the bronze period.

The weight of evidence thus tends to favour the idea that the fossil elk was coexistent with the men of Europe's Palæolithic age, by whom the reindeer was so largely turned to account, alike for food and the supply of material for their primitive arts; while it became extinct long before the more enduring reindeer withdrew entirely beyond the temperate zone. In Ireland, however, as hereafter noted, the abundant remains of its great fossil deer occur, geologically speaking, so nearly upon the horizon of its prehistoric dawn, and so little removed from some of the primitive evidences of man's presence there, that it will excite little surprise should further evidence of a wholly indisputable character demonstrate the survival of the Cervus megaceros within the Neolithic period, and contemporaneously with man; as in the remoter age of the Drift Folk of southern England it is now believed to have been an object of the chace, and a source of food, clothing, and tools.

When once it is admitted that the great fossil deer was contemporaneous with the men of central Europe, in its Reindeer period; and has to be included among the fauna familiar to the Drift Folk of southern England: this special question as to its survival in Ireland within any period of the presence of man has its chief value in relation to his own advent there; for this is not a mere question of geographical distribution, but deals with the relative

age of prehistoric man in Central Europe, in Southern England, and in the later post-pliocene areas of Northern Europe. Meanwhile it will suffice to note some of the discoveries which have already been advanced in favour of the idea that the great fossil deer of Ireland was not unknown to its earliest inhabitants as one of its living fauna.

Professor Jamieson and Dr. Mantell long ago noted the discovery, in the County of Cork, of a human body exhumed from a depth of eleven feet of peat bog. It lay in the spongy soil beneath. The soft parts were converted into adipocere, and the body, thus preserved, was enveloped in a deer-skin of such large dimensions as to lead them to the opinion that it belonged to the extinct Irish elk.

At the meeting of the British Association, at Newcastle, in 1863, Professor J. Beetes Jukes exhibited a right tibia, with a portion of one of the antlers of a Cervus megaceros, recovered from a bog near Logan, County Longford. They were found along with other remains of the skeleton, embedded in shell-marl two or three feet thick, resting on blue clay and gravel. A deep indentation on the tibia, about two inches broad and a quarter of an inch deep, was exactly fitted to receive the antler-tyne. "They looked," says Professor Jukes, "as if they had been each chipped out with some sharp instrument," and he added, "The impression left on my mind from a first inspection was that these indentations were the best evidence that had yet turned up in proof of man having been contemporaneous in Ireland with the Cervus megaceros, and having left his mark upon the horns of an animal soon after its death, which he had himself probably killed." * I was present in the section at the Newcastle meeting, and examined with much interest this supposed lethal weapon of the men of the era of the great Irish deer, adduced on such credible authority as seemingly determining the question of their coexistence in Ireland. But more careful observations, added to the apparent fact that the indented bones and antler had lain alongside of other portions of the skeleton embedded in the marle, has since led to the conclusion that this supposed primitive weapon was the chance product of natural processes still in force. Such seemingly artificial indentations and abrasions are now found to be by no means rare, as will be seen from specimens now produced, of similarly marked bones of the *Cervus megaceros*

* *Dublin Quarterly Journal of Science*, iv. 212.

from Loch Gur, County Limerick.* The opinion which is now generally accepted is that these abrasions and indentations are due to the juxtaposition of the sharp point or edge of one bone and the side of another, while subjected to a prolonged immersion in the moist clay or marl. But to this it is further assumed must be superadded the combined action of friction with pressure consequent on the motion of the bogs in which such bones are embedded. The boggy ground in which they chiefly occur is subject not only to a perpendicular oscillation, consequent on any vibration from passing weights shaking the ground, or even from the wind; but also it undergoes a periodical contraction and expansion by the alternate drying and saturating with moisture, in the summer and winter months; and thus indentations and cuttings, like those ordinarily ascribed to a flint knife or saw, are of frequent occurrence on the bones of the great fossil deer. To this subject Dr. A. Carte drew the attention of the Royal Geological Society of Dublin, in 1866, in a paper, entitled: "On some Indented Bones of the Cervus megaceros, found near Lough Gur, County Limerick," and I am now enabled to exhibit for your own inspection additional illustrations from the same locality illustrative of this phenomenon, furnished to me by Mr. Pride, Assistant-Curator of the University Museum.

In some of those the indentations are such as few would hesitate at first sight to ascribe to an artificial origin; and so to adduce them as evidence of the contemporaneous presence of man. But they occur, not on separate bones, but on portions of fossil skeletons recovered from the lough under circumstances which wholly preclude the idea that they had been detached and carried off for purposes of art; or that the indentations upon them can have been the work of human hands.

Professor Jukes was present when Dr. Carte's paper was read, and referred to former statements of his opposed to the idea of the contemporaneous presence in Ireland of man and the Cervus megaceros. "They knew," he said, "that man did exist contemporaneously with that animal in England; and then arose the geological question, was Ireland at that time already separated from England and the continent? Was the great plain which formerly connected the British

* The principal bones of a nearly complete skeleton of the *Cervus megaceros*, from Loch Gur, were exhibited to the Canadian Institute; and the various characteristic indentations, on what must have been an undisturbed skeleton in situ, were pointed out.

Islands with the continent already worn away, or had man already crossed over from England to Ireland? They knew that man had existed in England probably before England was separated from the continent."

But, whatever be the final determination on this interesting question of the co-existence of Man and the Cervus megaceros in Ireland, the bones of the latter are recovered there in enormous quantities, not infrequently in a condition admitting of their being even now turned to account for economic uses; and examples have undoubtedly been found there bearing unmistakeable evidence of human workmanship. One of the most interesting of these was an imperfect Irish lyre dug up in the moat of Desmond Castle, Adare, and exhibited by the Earl of Dunraven, at a meeting of the Archæological Institute in 1864. The relic was of value as a rare example of the most primitive form of the national musical instrument; but greater interest was conferred on it by the opinion pronounced by Professor Owen that it was fashioned from the bone of the Irish Elk.

In weighing such evidence it is manifestly important to keep prominently in view the fact already referred to, that the bones and horns of the fossil deer are recovered in a condition not less fit for working by the modern turner and carver than the mammoth ivory or the bog oak, which are now in constant use by them. In the Goat Hole Cavern at Paviland, Glamorganshire, Dr. Buckland noted the discovery of large rings or armlets and other personal ornaments made of fossil ivory, lying alongside of a human female skeleton, and in near proximity to the skull of a fossil elephant. The tusk of another fossil elephant, recovered at a depth of twenty feet in the boulder clay of the Carse of Sterling, is now preserved in the Edinburgh University Museum, in the mutilated condition in which it was rescued from the lathe of an ivory turner. This, so far as Scotland is concerned, is an exceptional example of the manufacture of fossil ivory, but we are very familiar with the fact that the tusks of the Siberian mammoth have long been an article of commerce.

In a paper "On the Crannoges of Lough Rea," by Mr. G. H. Kinohan, of the Geological Survey, read before the Royal Irish Academy in 1863, he describes a fine head of the Cervus megaceros found, along with abundant evidences of human art, in a large crannoge on Lough Rea. It measured thirteen feet from tip to tip of its horns; but Mr. Jukes suggested the probable solution of its discovery under

such circumstances to be, not that the megaceros had been hunted and killed by the crannoge builders, but that they had found the gigantic deer's head, "and put it up for an ornament or trophy, as is done at the present day."*

So far, at least, it thus appears,—notwithstanding the indisputable proofs of the employment of the bones and horns of the Cervus megaceros by primitive manufacturers of the Neolithic age; and the survival of this gigantic deer throughout the Palœolithic age of human art:—that evidence is still wanting to satisfy the scientific enquirer as to the co-existence of man and the great fossil deer in Ireland, where, more than in any other locality, this might be expected to occur. The primitive lyre found in the moat of Desmond Castle was undoubtedly fashioned from the bones of the extinct deer; but the material may have been recovered, as in modern times, from the marle of some neighbouring bog, and turned to account like the bog oak so abundantly used in modern art; rather than have been wrought by the Neolithic craftsman from the spoils of the chase.

In 1859, Sir W. R. Wilde read a lengthened communication at two successive meetings of the Royal Irish Academy, "Upon the unmanufactured animal remains belonging to the Academy." In arranging its collection of Irish Antiquities his attention was drawn to numerous crania and bones, chiefly of carnivora and ruminants, from river beds, bogs and crannoges; including sixteen crania, and upwards of seventy detached fragments of skeletons of the Cervus megaceros. The circumstances under which they were recovered have not been in all cases preserved, and no distinct evidence tends to confirm the idea of their contemporaneity with man. In remarking on the then novel recognition of the remains of Irish fossil deer in the tool-bearing gravel drifts of Abbeville, Sir W. R. Wilde observes: "As yet we have not discovered any Irish name for it. If the animal was here a contemporary of man, it certainly had become extinct long before the Irish had a knowledge of letters." † It is, however, altogether consistent with the evidence of a succession of races in the British Isles, and throughout Europe, to find that this era of the long extinct fossil mammalia pertaining to the Palæolithic, or even to the Neolithic age of primitive art, has no record in the oldest of the living languages. The same is true of others of

* *Dublin Quarterly Journal of Science*, iv., 125. † Proceedings of R. I. A. vii., 195.

the extinct mammalia, of which evidence of their familiarity to the men of the Neolithic period is abundant. It is indeed worthy of note that, while the ingenious artists of central Europe's Reindeer period have left wondrously graphic carvings and drawings of the mammoth, the fossil horse, and of the reindeer and other cervidæ, no very clearly recognizable drawing of the great fossil deer has been found. It has indeed been assumed to be the subject of more than one representation of a large horned deer, but the identification is at best doubtful. This is all the more noteworthy, as the characteristics of the great deer are such as could not fail to attract the notice of an artist capable of so successfully representing the salient features of the reindeer, as illustrated in familiar engravings of it, such as that from the Kesserloch, Schaffhausen, traced on a piece of one of its own antlers. If the engravings assumed to represent the Cervus megaceros are indeed efforts at its depiction, their less definite character may be due to the rarer opportunities for studying an unfamiliar subject.

But if, as Sir W. R. Wilde, says, no native Irish name has been discovered for the great fossil deer, an ingenious identification of it has been assumed with one of the objects of the chace referred to in the Niebelungen Lied. There, after the hunter has slain a bison, an elk, and four strong uruses, he crowns his feats with the slaying of a fierce *schelch.* It is no sufficient argument against such identification that the poem abounds with allusions to fire-dragons, giants, pigmies, and other fanciful creations. The "lusty beaver," the elk, "the ravin bear," and other contemporary, though now extinct, animals of Scotland, are introduced in the fanciful vision of "The King's Quair:"

"With many other beasts diverse and strange."

But any reasons adduced for identifying "the fierce schelch" of the Niebelungen Lied as the Cervus megaceros are sufficiently vague and slight; and so far the matured opinions of archæologists appear to coincide with those of the geologists, that this extinct deer did not coexist with man in Ireland.

But, whatever be the ultimate conclusion as to the period of its final disappearance there, no doubt is entertained as to this extinct deer having been contemporaneous with palæolithic man in western Europe, and even in England. Only two or three traces of its remains have been found in Scotland; and if in Ireland—seemingly its latest special habitat,—it had finally disappeared before the advent of man there; the results are significant in reference to the period of

its extinction; as well as to the order of a succession of events in the prehistoric dawn. Indications of the presence of man must be looked for as following in natural sequence to the geological reconstruction of specific areas, and their evidences of climatic changes in the post-glacial period. Sir John Lubbock remarks in his "Prehistoric Times," when referring to the *Cervus megaceros*: "Though there is no longer any doubt that this species coexisted with man, the evidence of this has been obtained from the bone-caves, and from strata belonging to the age of the river-drift gravels. No remains of the Irish elk have yet been found in association with bronze; nor indeed are we aware of any which can be referred to the later, or Neolithic Age." When the subject was under discussion at the meeting of the British Association at Dublin, Professor W. G. Adams affirmed most definitely the co-existence of palæolithic man and the fossil elk; while admitting the absence of any such evidence where the remains of the latter are now found in greatest abundance. "There is," he said, "no evidence that in Ireland man existed contemporary with the *Megaceros*, or had any thing to do with its extinction; whereas we have authentic evidences of the coexistence of man with this animal in England."

This conclusion, however consistent with the proofs thus far obtained, cannot as yet be recognized as one so absolutely settled as to render further research superfluous. Whistles formed of phalanges of the reindeer are among the most characteristic implements of the more ancient French caves; and one found by M. E. Piette, in 1871, along with various flint implements, in the Cavern of Gourdan (Haute-Garonne), pierced not only with a mouth-piece, but with finger-holes along the sides, is aptly described by him as a neolithic flute. There is nothing therefore in the mere design or workmanship of the primitive Irish lyre incompatible with its execution at the period when the Irish elk survived; if it can be shown that it was coeval with man in Ireland. Professor Boyd Dawkins when drawing attention to the fact that out of 48 well ascertained species living in the palaeolithic period, only 31 are found surviving into the neolithic period, adds: "The cave bear, cave lion, and cave hyæna had vanished away, along with a whole group of pachyderms; and of all the extinct animals, but one, the Irish elk, still survived." There is indeed something peculiar and exceptional in this magnificent deer which so specially claims a place among the extinct mam-

malia of prehistoric Ireland. Its range, alike in place and in time, appears to have been more circumscribed than that of most, if not all of the animals with which it is found associated in post-pliocene deposits. Traces of it, indeed, have not only been noted to the south of the Alps, but Professor Brandt has identified its remains among the cave disclosures of the Altai Mountains. But on both continents it had a similar temperate range; and no remains of it have been discovered in the extreme north of Europe. To this the nature of its food may have contributed; while the mammoth and the reindeer were able to subsist within the Arctic circle, as well as in temperate ranges common to them and to the gigantic elk. But circumscribed though the range of the latter appears to have been, its enormous dimensions, conjoined with seemingly gregarious habits, were incompatible with limits so greatly restricted as the Isle of Man, if not indeed with those of Ireland; and hence the probability of the assumption that its extinction preceded, or speedily followed the period when the British Islands became detached from the Continent of Europe.

The *Cervus megaceros* attained a height of nearly eleven feet, and bore an enormous pair of antlers, measuring at times nearly fourteen feet from tip to tip. The head, with its ponderous pair of antlers, is estimated to have exceeded 100 lbs. in weight when living. To this the frequent miring of the deer in the lakes and bogs, where their remains abound, has been ascribed; nor is it improbable that the ultimate extinction of the species may have been due to the abnormal development of such head-gear, while its large antlered contemporary, the Reindeer, still survives.

Mr. R. J. Moss was led from his former careful observations to conclude that Ballybetagh Bog occupies the site of an ancient lake or tarn which stretched along the bottom of the glen. The west side of the glen is flanked by the southern side of a hill, and another of less elevation hems it in on the east. The embouchure of the lake appears to have been at the southern end; and whether we assume that the deer when swimming across the lake got entangled in the stiff clay at the bottom, and so were drowned; or that they resorted to the lake to die, it would seem that their bodies drifted with the current to the outlet of the lake, and hence the enormous accumulation of their remains in one place. In describing one of the trenches opened by him, Mr. Moss says; "At the north end

the stony bottom was reached at a depth of only four feet; it dipped towards the southern end, where it was about five feet from the surface. The northern half of this trench did not contain a single fragment of bone or horn; the southern half was literally packed with them." * The remains found in the course of this exploration represented about fifty individuals, the majority of the bones being those of young deer.

The result of the more hasty excavations recently made, was the discovery of two skulls and several portions of horns on the first day. On the second day a trench was opened, and cut through an accumulation of 27 inches of peat, resting upon about 22 inches of sandy clay, intermingled with roots and traces of various forms of vegetation. Underneath this among granite boulders, three fine heads were found; one of them of the largest size, and in nearly perfect preservation, with antlers measuring about eleven and a half feet from tip to tip.

There was something startling in the success of our expedition: thus setting out from the busy scenes of Dublin, with all the bustle of its crowded thoroughfares, and not less crowded scientific sections; and landing among wild uncultured bogs, to dig down, and at once light upon the remarkable evidences of an extinct fauna once so abundant. There were not even wanting sceptical doubters ready to hint at previous preparations having facilitated a too easy discovery. In this, however, we profited by the careful and intelligent labours of Mr. Moss at an earlier date; and all who put themselves under his guidance were amply rewarded by the results.

It is worthy of note that, neither on this occasion, nor in the older excavations was a true marl found underlying the peat, or clay. The rock of the district is granite; being part of a band of granite five miles broad, which extends from Dublin Bay in a south-westerly direction into the County of Waterford. A granite sand was found in some places to a depth of three feet; and Mr. Moss, after careful examination, describes the underlying clays as almost entirely free from calcium carbonate, and having every appearance of a granitic origin. But a little to the north of the section thus described, a light-coloured marl, rich in calcium carbonate, makes its appearance almost under the turf.

* Proceedings R. I. A., 2nd Ser., Vol. II.

Thus far about eighty individuals of the great fossil elk, and one reindeer, are represented in the remains recovered from the Ballybetah Bog, without any traces of the co-existence of man having been observed. But no better locality could be chosen to test the question. Lying though this interesting locality does, in such near vicinity to the Irish metropolis, it has been left nearly untouched by the hand of man within the whole historic period, during which cathedral and castle, college, mart, and wharf, have crowded the banks of the Liffy. The traces of the primitive architecture of remoter eras have thereby escaped defacement. The general contour of the district remains little changed. The aspect is wild and savage; and it requires no very great exercise of the fancy to restore the ancient mere, reclothe its shores with forests, the buried trunks of which abound in the underlying peat, and reanimate them with the magnificent herds of the great fossil deer. Here are still the unefaced memorials of primitive art. On the rising ground on the south-east margin of the bog stands a large chambered cairn, which has been rifled; and the exposed chamber shows the megalithic structure characteristic of the most ancient works of this class. There is also a circle near it formed by an enclosure of stones and earth, which is regarded by the natives with superstitious awe. According to the belief of the peasants, if their cattle stray into this enclosure they will die.

Here, then, it is probable that the bed of the neighbouring tarn or bog must contain some evidences of the primitive arts of the Cairn-builders, with means for determining the relative date of their presence there, as compared with the true age of the *Cervus megaceros.* A report of the successful operations which rewarded the brief labours of the excursion party was made to the executive council of the British Association, and steps were taken with a view to a systematic and thorough exploration of this favourite haunt of the great fossil Irish elk, one of the most remarkable among the fauna of Europe's Palæolithic period.

ON THE OCCURRENCE OF PETROLEUM IN THE NORTH-WEST TERRITORIES, WITH NOTES ON NEW LOCALITIES.

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The existence of petroleum at several places on the Athabaska River has long been known. Numerous details on the subject are to be found in Sir John Richardson's Journal of a Boat Voyage in 1848. Some of these localities are also described by Professor Macoun, Botanist to the Geological Survey, who passed through the same region in 1875, and noticed an additional locality on the Peace River, about 100 miles west of its junction with the Slave River. Last autumn I was informed of the occurrence of petroleum in some new localities further north than those hitherto known, by Mr. Hardisty, formerly resident at Fort Simpson, who kindly gave me particulars in regard to them. In 1877, I was able to establish the Devonian age of the rocks lying to the south of James' Bay, and one of my assistants discovered indications of petroleum in these strata about fifty miles from Moose Factory.

All these oil regions have certain geological relations in common. Having collected together all the notes by explorers who have written about such matters, as well as any information which I could gain from other travellers, I propose to offer a few remarks upon the subject. I shall first refer to the localities in the Athabaska-McKenzie Valley, enumerating them in their order from south to north.

In following the ordinary route of travel from the southward, this valley is entered by a sudden descent of 600 feet to the Clear-water River at the north end of the Methye Portage, which leads across from the head-waters of the Churchill River. The Clear-water is a small stream flowing westward to the Athabaska. The first known

locality for petroleum is met with on this river ten miles from its junction with the main Athabaska, at which distance, Professor Macoun says, "the men pointed out a tar-spring in the stream, at which they very often got tar."

He also states that tar oozes from the black shales, 150 feet thick, at the forks of these two rivers. Sir John Richardson says these shales are underlaid by soft limestone, "which forms the banks of Athabaska River for thirty-six miles downwards" (from the forks). "The beds vary in structure, the concretionary form rather prevailing, though some layers are more homogeneous and others are stained with bitumen." Limestones, occupying a similar position, re-appear on the Peace River near the oil-spring, already referred to, and are there described by Professor Macoun as "almost wholly made up of those branching corals (*Alveolites*) so common in Devonian rocks, intermixed with a species of *Zaphrentis* in great abundance, some of the higher strata being largely made up of these." When at a part of the river about midway between the forks and Athabaska Lake, a distance of about one hundred miles, the same gentleman remarks: "I found below a light grey sandstone, partly saturated with the tar, and overlying this, there was at least fifteen feet of it completely saturated, and over this again, shale largely charged with alkaline matter. This was the sequence all the way, although at times there was much more exposed. Where we landed the ooze from the bank had flowed down the slope into the water and formed a tarred surface extending along the beach over one hundred yards, and as hard as iron; but in bright sunshine the surface is quite soft, and the men when tracking along shore often sink into it up to their ankles." Sir John Richardson says: "About thirty miles below the Clearwater River the limestone-beds are covered by a bituminous deposit upwards of one hundred feet thick, whose lower member is a conglomerate having an earthy basis much stained with iron and colored by bitumen. * * Some of the beds above this (conglomerate) stone are nearly plastic from the quantity of mineral-pitch they contain. Roots of living trees and herbaceous plants push themselves deep into beds highly impregnated with bitumen; and the forest where that mineral is most abundant does not suffer in its growth. * * Further down the river still, or about three miles down the Red River (of the Athabaska), where there was once a trading establishment, now remembered as 'La Vieux Fort de la Rivière

Rouge,' a copious spring of mineral pitch issues from a crevice composed of sand and bitumen. It lies a few hundred yards back from the river in the middle of a thick wood. Several small birds were found suffocated in the pitch." * * At the deserted fort named 'Pierre au Calumet,' cream-colored and white limestone cliffs are covered by thick beds of bituminous sand. * * A few miles further on the cliffs for some distance are sandy, and the different beds contain variable quantities of bitumen. Some of the lower layers were so full of that mineral as to soften in the hand, while the upper strata, containing less, were so cemented by iron as to form a firm dark-brown sandstone of much hardness. * * The whole country for many miles is so full of bitumen that it flows readily into a pit dug a few feet below the surface. In no place did I observe the limestone alternating with these sandy bituminous beds, but in several localities it is itself highly bituminous, contains shells filled with that mineral, and when struck yields the odor of *stinkstein*." Elsewhere, this author describes these bituminiferous sands as resting unconformably upon the limestones, and, indeed, they must be of much more recent age, as he states that "in one of the cliffs not far below the Clear-water River, the indurated arenaceous beds resting on the limestone contain pretty thick layers of lignite, much impregnated with bitumen, which has been ascertained by Mr. Bowerbank to be of coniferous origin, though he could not determine the genus of the wood."

In approaching Athabaska Lake the banks of the river of the same name become low and consist of gravel and reddish earth, then sand and finally only alluvial soil. The last evidence of the bitumen consists of rolled balls on pebbles of sand cemented together by the tar, which have been carried down by the river. According to Prof. Maconn, these balls are very abundant and in places form beds of "tar conglomerate" in the river banks often two feet thick. Mr. Hardisty, who passed up this river last summer (1878), informs me that the banks on both sides are frequently composed of sand cemented by pitch, which softens in the sun and renders the walking very disagreeable. Masses of the more hardened varieties lie about on the river shores like lumps of coal.

At its western extremity, Athabaska Lake discharges its waters northward by the Slave River into Slave Lake, receiving the Peace River from the west, a short distance below the outlet. Fort Chipe-

wyan is situated on Athabaska Lake where Slave River leaves it and Fort Resolution is built on the south shore of Slave Lake where the same river enters it. Sir John Richardson says that on this river, thirty miles from Fort Chipewyan, there is a limestone cliff "the lower beds of which have a compact structure, a flat conchoidal fracture and a yellowish-grey color. Some of the upper beds contain mineral pitch in fissures" and they also hold Devonian fossils.

The western extremity of Slave Lake is about 115 miles west of Fort Resolution and here it discharges its waters by the McKenzie River. Numerous islands occur in this part of the lake, the largest of which is Big Island, so celebrated in the writings of northern travellers for its productive fishery. The next localities for petroleum which I shall notice are two of those about which I was informed by my friend Mr. Hardisty. One of them is situated about ten miles north-eastward of the Big Island Fishery. Here the oil rises from the bottom of the lake in about five feet of water, in a bay, and at a distance of a mile and a half from the shore. This bay is the one most nearly opposite to Big Island. The petroleum is of a dark color and in calm weather in summer it spreads itself over the surface of the lake, but in winter it keeps the water open directly over the source from which it rises, forming a round hole in the ice, in which it accumulates to a sufficient depth to be easily dipped out. It has the ordinary smell of petroleum, is very liquid and when thrown upon a fire it explodes. In many places along this part of the north shore of the lake petroleum oozes out of the earth and its smell is quite noticeable to the traveller in passing by the coast. On the main shore of the next bay east of the one above referred to, there is a copious spring or puddle of tar and pitch mixed with leaves and sticks, which, if cleared out, would no doubt fill up with liquid oil. This spring was discovered by Mr. John Hope, of the Hudson Bay Company. The western part of Slave Lake is shallow and its bottom and shores are underlaid by bituminous limestone and dark, bituminous shales of Devonian age. Mr. Woodward in referring to some of the corals from these limestones mentions that their cysts are filled with bitumen.

Perhaps the most remarkable locality for petroleum in the North-West Territories is one described to me by Mr. Hardisty as occurring about seventy miles eastward of Fort Simpson, which is situated on the McKenzie River at the junction of the Liard. This locality is

in the depths of the forest, near no lake or stream of sufficient size to mark the place. The oil issues from springs in the form of great holes in the ground, down which poles may be plunged as far as they will reach without meeting with any resistance beyond that of the slimy liquid. The Indians fill tight boxes with the partially inspissated petroleum at these springs and haul it to Fort Simpson on sleighs in winter. Here it is boiled down to a proper consistence and used for pitching boats.

In giving a general description of the geology of the McKenzie River, Richardson says, "a shaly formation makes the chief part of the banks and also much of the undulating valleys between the elevated spurs. It is based on horizontal beds of limestone and in some places of sandstone which abut against the inclined strata of the lofty wall-like ridges or rests partially on their edges. The shale crumbles readily and often takes fire spontaneously, occasioning the ruin of the bank, so that it is only by the encroachment of the river carrying away the *debris* that the true structure is revealed." At a high point below Fort Simpson, known as "The Rock by the River's Side," the bituminous shales are described as having a very great similarity to those at the junction of the Clear-water and Athabaska Rivers. The same author describes thick beds of bituminous shale as occurring on the western shores of Great Bear Lake, which discharges westward by a comparatively short river into the McKenzie River. Below the confluence of these great streams the same shale is seen running down the banks of the one last mentioned. "Underlying the shale, horizontal beds of lime are exposed for some miles along the McKenzie and from them issue springs of saline sulphurous waters and mineral pitch." In approaching the Artic Ocean the McKenzie River is hemmed in to a width of only about one-third of a mile by rocks which, from their forms, have given the locality the name of "The Ramparts." Here Richardson says, "the cliffs have been denuded of the covering of shale which exists higher up the stream, but the limestone of which they are chiefly formed is stained with bitumen either in patches or whole layers."

From the foregoing it will be perceived that I have traced a highly bituminous character in the rocks of the Athabaska-McKenzie Valley all the way from the Clear-water branch to the Ramparts, a distance of no less than one thousand miles in a straight line. The continuation of the same rocks is known to extend to the northward

and to the southward of the above limits far enough to give a total length of two thousand miles. They belong to the Devonian system and have a strong resemblance to the petroleum-bearing strata of Western Ontario. The corals of the Corniferous formation are often filled with bitumen like those of the limestones of the Athabaska and McKenzie Rivers; and the pyrites and carbonaceous matter of the black shales of Kettle Point, on Lake Huron, under the influence of air and moisture, have given rise to a sort of spontaneous combustion like that of the shale of the McKenzie. Southward of the Clear-water River the petroleum-bearing formation strikes across the Saskatchewan, between Cumberland House and The Forks, and, passing through lakes Winnipegosis and Manitoba, it continues southward up the Red River valley, and is lost in the United States. On the shore of Lake Winnipegosis, brine springs issue from these rocks, and salt is also found in abundance near Slave River and between Slave Lake and Great Bear Lake. Petroleum may be looked for all along the strike of this great Devonian formation in our North-West Territories, including the tract at the eastern base of the high grounds on the west side of the lakes of the Winnipeg basin.

I shall conclude by referring very briefly to the indications of petroleum found to the south of James' Bay. In this region the limestones have a strong resemblance to those of the Athabaska, being of a yellowish color, and more or less of a bituminous character. The fossils which I collected in 1875 and 1877 on the Moose River and its branches have established the Devonian age of the formation. Gypsum and carbonate of iron occur in it in quantities of economic value. In 1877, on the Abittibi branch of the Moose, thirty-nine miles from its mouth, Mr. A. S. Cochrane, a member of my party, found a brownish-black shale, like that of the Athabaska, which emits a bright flame and an odor of sulphur when strongly heated. This shale is underlaid, as on the Athabaska, by soft bituminous yellow limestone, at one place impregnated with petroleum, which extends for ten miles up the river. In this district, as well as in the North-West Territory, these rocks consist of pure carbonate of lime, while the underlying Silurian strata, in both regions, are dolomitic.

NOTES ON RELATIVE MOTION.

BY JAMES LOUDON,
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1. Motion of a point in a plane.

At time t let the moving axes be $O\xi$, $O\eta$, and P a point (ξ, η) in their plane. At time $t + \delta t$ let these axes coincide with $O\xi'$, $O\eta'$, and P with P'; then the ξ and η components of the displacement PP' are $-\omega\eta\delta t$, $\omega\xi\delta t$, respectively, if ω is the rate at which the axes turn round $O\zeta$. Let a moving point be at P at time t, and at Q at time $t + \delta t$, the co-ordinates of Q referred to $O\xi'$, $O\eta'$ being $\xi + \dot\xi\delta t$, $\eta + \dot\eta\delta t$; then the absolute velocity of the moving point is ultimately $\frac{PQ}{\delta t} = \left(\frac{PP'}{\delta t}, \frac{P'Q}{\delta t}\right)$, the ξ and η components of which are $\dot\xi - \omega\eta$, $\dot\eta + \omega\xi$, respectively.

Putting $\dot\xi - \omega\eta = u = OA$, and $\dot\eta + \omega\xi = v = OB$, the component velocities at time $t + \delta t$ become $u + \dot u\delta t = OA'$ along $O\xi'$, and $v + \dot v\delta t = OB'$ along $O\eta'$. Hence the absolute acceleration ultimately $= \left(\frac{AA'}{\delta t}, \frac{BB'}{\delta t}\right)$, the components of which are

$$\dot u - v\omega = \ddot\xi - 2\,\omega\dot\eta - \eta\dot\omega - \omega^2\xi \text{ along } O\xi,$$
$$\dot v + u\omega = \ddot\eta + 2\,\omega\dot\xi + \xi\dot\omega - \omega^2\eta \text{ along } O\eta.$$

2. Motion of a rigid body round a fixed axis $O\zeta$, the axes $O\xi$, $O\eta$ being fixed in the body.

At time t the whole momentum is $-M\omega\eta = OA$ along $O\xi$, and $M\omega\xi = OB$ along $O\eta$, where ξ, η are co-ordinates of the centre of inertia. At time $t + \delta t$ the momentum is $-M\eta\,(\omega + \dot\omega\delta t) = OA'$ along $O\xi'$, and $M\xi\,(\omega + \dot\omega\delta t) = OB'$ along $O\eta'$. The changes of momentum per unit time are, therefore, ultimately $\frac{AA'}{\delta t}$, $\frac{BB'}{\delta t}$, whose components are

$$-M\eta\dot\omega - M\omega^2\xi \text{ along } O\xi,$$
$$M\xi\dot\omega - M\omega^2\eta \text{ along } O\eta.$$

At time t the whole moment of momentum is (employing OA, OB in a new sense)

$$-\beta\omega = OA \text{ along } O\xi,$$
$$-a\omega = OB \text{ along } O\eta,$$
$$C\omega \ldots\ldots \text{ along } O\zeta,$$

where $a = \Sigma m\eta\zeta, \quad C = \Sigma m\,(\xi^2 + \eta^2)$, etc.

At time $t + \delta t$ the moment of momentum becomes

$$-\beta\,(\omega + \dot\omega\delta t) = OA' \text{ along } O\xi',$$
$$-a\,(\omega + \dot\omega\delta t) = OB' \text{ along } O\eta', \text{ etc.}$$

Hence the changes per unit time of moment of momentum are ultimately $\frac{AA'}{\delta t}$, $\frac{BB'}{\delta t}$, $C\dot\omega$, the components of which are $-\beta\dot\omega + a\omega^2$ along $O\xi$, $-a\dot\omega - \beta\omega^2$ along $O\eta$, and $C\dot\omega$ along $O\zeta$.

These, it will be observed, are of the same form as when the axes are fixed in space.

3. To measure the absolute velocity and acceleration of a point referred to axes moving in space round O.

Let the motion of the axes be due to rotations θ_1, θ_2, θ_3 measured along themselves. Then, proceeding as in § 1, the displacements of a point P (ξ, η, ζ) due to these rotations are $(\zeta\theta_2 - \eta\theta_3)\,\delta t$ along $O\xi$, $(\xi\theta_3 - \xi\theta_1)\,\delta t$ along $O\eta$, and $(\eta\theta_1 - \xi\theta_2)\,\delta t$ along $O\zeta$. These added to the relative displacements $(\dot\xi\delta t, \dot\eta\delta t, \dot\zeta\delta t)$ of the moving point give the absolute displacements. Hence the components of the absolute velocity are

$$u = OA = \dot\xi + \zeta\theta_2 - \eta\theta_3 \text{ along } O\xi,$$
$$v = OB = \dot\eta + \xi\theta_3 - \zeta\theta_1 \text{ along } O\eta,$$
$$w = OC = \dot\zeta + \eta\theta_1 - \xi\theta_2 \text{ along } O\zeta.$$

Again, let the velocities at time $t + \delta t$ be $OA' = u + \dot u\delta t$ along $O\xi'$, etc.; then the absolute accelerations are ultimately $\frac{AA'}{\delta t}$, $\frac{BB'}{\delta t}$, $\frac{CC'}{\delta t}$, whose components are

$$\dot u - v\theta_3 + w\theta_2 \text{ along } O\xi,$$
$$\dot v - w\theta_1 + u\theta_3 \text{ along } O\eta,$$
$$\dot w - u\theta_2 + v\theta_1 \text{ along } O\zeta.$$

These become, on reduction,

$$\ddot\xi - 2\,\theta_3\dot\eta + 2\,\theta_2\dot\zeta + \zeta\dot\theta_2 - \eta\dot\theta_3 - (\theta_1^2 + \theta_2^2 + \theta_3^2)\,\xi + (\xi\theta_1 + \eta\theta_2 + \zeta\theta_3)\,\theta_1$$

along $O\xi$, etc.

NOTE.—These resolutions are most readily effected as follows: AA' is equivalent to AD along $O\eta$, DH along $O\zeta$, and HA' along $O\xi$; and similar

resolutions are effected for BB', CC'. The values of AD, DH, etc., are at once derived from the displacements in time δt of the points (1, 0, 0), (0, 1, 0), (0, 0, 1). The latter are, respectively,

$$\begin{array}{ccc} 0\,, & \theta_3\,, & \theta_2\,, \\ -\theta_3\,, & 0\,, & \theta_1\,, \\ \theta_2\,, & \theta_1\,, & 0\,, \end{array}$$

each multiplied by δt; from which the values of AD, DH, etc., are obtained by multiplying the first set by OA, the second by OB, and the third by OC. Moreover, the parts HA', etc., remain unchanged in magnitude when resolved along $O\xi$, $O\eta$, $O\zeta$, if infinitesimals above the first order be neglected. Thus, in the present case, $HA = \dot{u}\delta t$, $AD = u\theta_3\delta t$, $DH = -u\theta_2\delta t$.

4. If, in the previous case, the origin moves, its acceleration must of course be added to the expressions found in § 3. These formulas may be tested by the following well-known example. Let O be on the earth's surface in latitude λ, and let $O\xi$ be drawn south, $O\eta$ east, and $O\zeta$ vertical. Then ω being the earth's rotation and r its radius, the accelerations of O are

$$\begin{array}{ll} -\omega^2 r \cos\lambda \sin\lambda \text{ along } O\xi, \\ -\omega^2 r \cos^2\lambda \qquad \text{"} \quad O\zeta. \end{array}$$

Also, $\theta_1 = -\omega\cos\lambda$, $\theta_2 = 0$, $\theta_3 = \omega\sin\lambda$, and $\dot{\theta}_1 = 0 = \dot{\theta}_2 = \dot{\theta}_3$. Hence the acceleration of m at (ξ, η, ζ) are

$$\begin{array}{l} \ddot{\xi} - \omega^2 r\cos\lambda\sin\lambda - 2\,\omega\dot{\eta}\sin\lambda - \omega^2\xi\sin^2\lambda - \omega^2\zeta\sin\lambda\cos\lambda, \\ \ddot{\eta} + 2\,\omega\dot{\zeta}\cos\lambda + 2\,\omega\dot{\xi}\sin\lambda - \omega^2\eta, \\ \ddot{\zeta} - \omega^2 r\cos^2\lambda - 2\,\omega\dot{\eta}\cos\lambda - \omega^2\zeta\cos^2\lambda - \omega^2\xi\sin\lambda\cos\lambda, \end{array}$$

along $O\xi$, $O\eta$, $O\zeta$, respectively.

5. To measure the changes in the rotation of a rigid body with one point fixed, the axes moving as in § 3. Let the rotations to which the displacement of the body is due be at time t, $\omega_1 = OA$, $\omega_2 = OB$, $\omega_3 = OC$ measured respectively along $O\xi$, $O\eta$, $O\zeta$. Then since at time $t + \delta t$ these become $\omega_1 + \dot{\omega}_1\delta t = OA'$, etc., along $O\xi'$, $O\eta'$, $O\zeta'$, the absolute changes per unit time in the rotation are ultimately

$$\frac{AA'}{\delta t},\ \frac{BB'}{\delta t},\ \frac{CC'}{\delta t}.$$

Resolving these, we get for the required components

$$\dot{\omega}_1 - \omega_2\theta_3 + \omega_3\theta_2 \text{ along } O\xi, \text{ etc.}$$

6. To measure the change in the whole absolute momentum of a rigid body, one point of which is fixed at O, the axes moving as in §§ 3, 5. Since the absolute momentum of m in the position (ξ, η, ζ) at time t is

$$m\left\{\zeta\,(\omega_2 + \theta_2) - \eta\,(\omega_3 + \theta_3)\right\} \text{ along } O\xi, \text{ etc.,}$$

it follows that the whole absolute momentum at that time is

$$z(\omega_2+\theta_2)-y(\omega_3+\theta_3) \text{ along } O\xi,$$
$$x(\omega_3+\theta_3)-z(\omega_1+\theta_1) \text{ along } O\eta,$$
$$y(\omega_1+\theta_1)-x(\omega_2+\theta_2) \text{ along } O\zeta,$$

each multiplied by M, where (x, y, z) is the position of the centre of inertia. Calling these components $\mu_1 = OA$, $\mu_2 = OB$, $\mu_3 = OC$, respectively, it follows that at time $t+\delta t$ they become $\mu_1 + \dot{\mu}_1 t = OA'$ along $O\xi'$, $\mu_2 + \dot{\mu}_2\delta t = OB'$ along $O\eta'$, $\mu_3 + \dot{\mu}_3\delta t = OC'$ along $O\zeta'$. The changes in the whole momentum per unit time are, therefore, $\frac{AA'}{\delta t}$, $\frac{BB'}{\delta t}$, $\frac{CC'}{\delta t}$, whose components are

$$\dot{\mu}_1 - \mu_2\theta_3 + \mu_3\theta_2 \text{ along } O\xi,$$
$$\dot{\mu}_2 - \mu_3\theta_1 + \mu_1\theta_3 \text{ along } O\eta,$$
$$\dot{\mu}_3 - \mu_1\theta_2 + \mu_2\theta_1 \text{ along } O\zeta.$$

Since $\dot{x} = z\omega_2 - y\omega_3$, etc., these expressions become, on reduction, M times

$$z(\dot{\omega}_2+\dot{\theta}_2)-y(\dot{\omega}_3+\dot{\theta}_3)+\omega_1\left\{(\omega_1+\theta_1)x+(\omega_2+\theta_2)y_2+(\omega_3+\theta_3)z\right\}$$
$$+(\omega_1+\theta_1)(\theta_1 x+\theta_2 y+\theta_3 z)-x\left\{(\omega_1+\theta_1)^2+(\omega_2+\theta_2)^2+(\omega_3+\theta_3)^2\right\}$$

for the first, with similar values for the other two.

7. To measure the changes in the whole absolute moment of momentum under the same circumstances as in § 6. Since the absolute moment of m's momentum at time t is m times

$$(\omega_1+\theta_1)(\eta^2+\zeta^2)-(\omega_2+\theta_2)\xi\eta-(\omega_3+\theta_3)\zeta\xi \text{ along } O\xi,$$

with corresponding components along $O\eta$, $O\zeta$, it follows that the components of the whole moment of momentum at that time are

$$A(\omega_1+\theta_1)-\gamma(\omega_2+\theta_2)-\beta(\omega_3+\theta_3) \text{ along } O\xi,$$
$$-\gamma(\omega_1+\theta_1)+B(\omega_2+\theta_2)-\alpha(\omega_3+\theta_3) \text{ along } O\eta,$$
$$-\beta(\omega_1-\theta_1)-\alpha(\omega_2+\theta_2)+C(\omega_3+\theta_3) \text{ along } O\zeta,$$

where $\qquad A = \Sigma m(\eta^2+\zeta^2), \quad \alpha = \Sigma m\eta\zeta$, etc.

Let these components be called $\nu_1 = OA$, $\nu_2 = OB$, $\nu_3 = OC$, respectively. Then at time $t+\delta t$ they become $\nu_1 + \dot{\nu}_1\delta t = OA'$ along $O\xi'$, $\nu_2 + \dot{\nu}_2\delta t = OB'$ along $O\eta'$, and $\nu_3 + \dot{\nu}_3\delta t = OC'$ along $O\zeta'$. Hence the changes of the moment of momentum per unit time are

$$\frac{AA'}{\delta t}, \frac{BB'}{\delta t}, \frac{CC'}{\delta t},$$

whose components are

$$\dot{\nu}_1 - \nu_2\theta_3 + \nu_3\theta_2 \text{ along } O\xi,$$
$$\dot{\nu}_2 - \nu_3\theta_1 + \nu_1\theta_3 \text{ along } O\eta,$$
$$\dot{\nu}_3 - \nu_1\theta_2 + \nu_2\theta_1 \text{ along } O\zeta,$$

Now, since $\dot{\xi} = \zeta\omega_2 - \eta\omega_3$, etc., it follows that

$$\begin{aligned}
\dot{A} &= 2\,\Sigma m\,(\eta\dot{\eta} + \zeta\dot{\zeta}) \\
&= 2\,(\gamma\omega_3 - \beta\omega_2) \\
\dot{B} &= 2\,(\alpha\omega_1 - \gamma\omega_3) \\
\dot{C} &= 2\,(\beta\omega_2 - \alpha\omega_1) \\
\dot{\alpha} &= \Sigma m\,(\eta\dot{\zeta} + \zeta\dot{\eta}) \\
&= (C - B)\,\omega_1 - \gamma\omega_2 + \beta\omega_3 \\
\dot{\beta} &= \gamma\omega_1 + (A - C)\,\omega_2 - \alpha\omega_3 \\
\dot{\gamma} &= -\beta\omega_1 + \alpha\omega_2 + (B - A)\omega_3.
\end{aligned}$$

Hence the above values for the component changes of moment of momentum become

$$\begin{aligned}
&A\,(\dot{\omega}_1 + \dot{\theta}_1) - \gamma\,(\dot{\omega}_2 + \dot{\theta}_2) - \beta\,(\dot{\omega}_3 + \dot{\theta}_3) + 2\,(\omega_1 + \theta_1)\,(\gamma\omega_3 - \beta\omega_2) \\
&\quad - (\omega_2 + \theta_2)\,[-\beta\omega_1 + \alpha\omega_2 + (B - A)\,\omega_3] - (\omega_3 + \theta_3)\,[\gamma\omega_1 + \\
&\quad (A - C)\,\omega_2 - \alpha\omega_3] - \theta_3\,[-\gamma\,(\omega_1 + \theta_1) + B\,(\omega_2 + \theta_2) - \alpha\,(\omega_3 + \\
&\quad \theta_3)] + \theta_2\,[-\beta\,(\omega_1 + \theta_1) - \alpha\,(\omega_2 + \theta_2) + C\,(\omega_3 + \theta_3)]
\end{aligned}$$

for the first; with similar expressions for the other two.

CANADIAN INSTITUTE.

REPORT OF THE COUNCIL FOR 1880–81.

The Council of the Canadian Institute in presenting their Thirty Second Annual Report, are gratified in being able once more to congratulate the Institute on another year of satisfactory work throughout the Winter Session.

The advantages resulting from the admirable accommodation for all the ordinary meetings of the Institute which the new building supplies, fully justify the action of the Council in recent years in incurring an outlay necessarily involving a burden of debt, which must continue for some time to hamper the action of the Institute in various ways; and especially to absorb to a large extent the funds which would otherwise be available for the important object of the printing proceedings. So important has it appeared to the Council to reduce the debt as speedily as possible, that however reluctant to delay the issue of their printed proceedings, they have allowed a year to elapse without any new issue. This has enabled the Treasurer to devote the money to the reduction of the debt, and the Council have accordingly the satisfaction of reporting a diminution of the capital sum due, and a corresponding reduction of the annual charge payable on the mortgage effected on the building.

The debt remaining at the close of the last financial year amounted to $5,500, involving an annual payment of interest of $440. Since then the Treasurer has made a further payment of $500 in reduction of the mortgage debt, reducing it to $5,000; and also has effected an arrangement whereby the annual interest is reduced from 8 per cent. to 7 per cent., making the amount of present annual interest $350.

It is inevitable that the existence of a debt involving an annual charge which absorbs to so large an extent the annual surplus over and above ordinary expenditure, must hamper the exertions of the Council and of all the members of the Institute; and greatly diminish its efforts in the cause of Canadian Science and Letters. The Council accordingly recommend to their successors and to the members at large, a renewed effort for the reduction of this debt, so as to place at their disposal an annual revenue adequate for the printing of the proceedings, and the carrying out on an adequate scale the legitimate work of the Institute.

Appended to this Report are abstracts showing—(1) The present condition of the membership, including 124 ordinary and life members; (2) The Papers communicated at the meetings during the year; (3) The additions to the Library during the same period, and (4) The Treasurer's balance sheet, with a report of the receipts and liabilities of the Institute at the present date.

All which is respectfully reported.

DAN. WILSON,
President.

FINANCIAL STATEMENT.

REPORT OF TREASURER ON INCOME AND EXPENDITURE FROM 1ST APRIL, 1880, TO 1ST APRIL, 1881.

1880. *Debtor.*	
To Summary.	$ cts.
" Annual Subscriptions	362 00
" Government Grants	1,500 00
" Journals sold	7 13
" Subscriptions to Building Fund	213 00
" Rent from Warehouse	83 00
	$3,165 13

1880. *Creditor.*	
By Summary.	$ cts.
" Amount due to Treasnrer	153 86
" Express Charges	7 35
" Gas Supply	5 96
" Water Supply	17 25
" Advertising	31 00
" Postage	3 87
" Lecture Fee	4 00
" Honsekeeping Contingencies	6 10
" Repairs	6 12
" Fuel	68 75
" Taxes	11 39
" Magazines	82 45
" Salary to Secretary	336 00
" Binding of Books	7 20
" Reduction of Mortgage	500 00
" Interest on Mortgage	412 50
" Cash in hand	511 33
	$2,165 13

COPY OF CERTIFICATE FROM AUDITORS.

We Certify to having compared the vouchers of the above entries of expenditure, and find the same correct. The amount of receipts is properly added, shewing balance in Treasurer's hands of five hundred and eleven $\frac{33}{100}$ dollars.

WM. HENDERSON.
GEORGE MURRAY.

COMMENTS.

It will be seen that two annual Government Grants appear in this year. This results from the earlier meeting of the Legislature in 1881 and earlier obtainment of the Grant.

The total amount of receipts from subscriptions to the Building Fund is $1,347.00, of which $1,000.00 has been applied to the reduction of debt, said debt being now $5,000.00, and the interest has been reduced from 8% to 7%, by permission of the Mortgagee.

COMMUNICATIONS.

The following valuable and interesting papers and communications were read and received from time to time at the ordinary meetings held during the Session 1880-81 :

April 3, 1880.—By T. H. Monk, Esq., on "Vital Statistics." Prof. Ramsay Wright, described some West Indian Flukes, exhibited by Mr. Troutman, L.D.S.

April 17, 1880.—Prof. Jas. Loudon, M.A., "Investigations in Relative Motion." Dr. Daniel Wilson, LL.D., on the "Imitative Faculty as a Race Distinction."

May 1, 1880.—Prof. Macoun, M.A., on the "Climate of Manitoba and the North-West Territory."

October 30, 1880.—Dr. Daniel Wilson, LL.D., Inaugural Address, on the "Independent Origin of Written Language on the American Continent."

November 27, 1880.—Dr. Daniel Wilson, LL.D., on the "Mare Crisium," illustrated by telescopic views, illustrative of Lunar Physics. Prof. R. Ramsay Wright, exhibited a series of wax models, illustrative of Natural History. Dr. Jos. Workman, on "Marco-Elepsia."

December 11, 1880.—Dr. Jos. Workman, on "Moral Insanity; What is it?".

January 8, 1881.—A communication from the Director of the Imperial Observatory of Poulkova, on the "Proposal for establishing a Prime Meridian," by Sandford Fleming, C.M.G. Dr. Daniel Wilson, LL.D., on the "History of the Calendar."

January 22, 1881.—John Notman, Esq., on "Meteors." A. Elvins, Esq., on the "Mare Imbrium, and Lunar Crater Copernicus," illustrated by Photographic views taken by the author.

February 19, 1881.—C. B. Biggar, Esq., on the "Climate of South Africa." Wm. Oldright, M.A., M.D., on "Sanitary Legislation."

March 5, 1881.—A. H. Elwin, C. E., on "Some of Faraday's theories of Electricity."

April 2, 1881.—Rev. Dr. Scadding: "A Boy's Books; Then and Now—1818-1881."

April 16, 1881.—Dr. Daniel Wilson, "Some Notes on Ben. Jonson and his Orthography."

April 23, 1881.—Rev. Dr. Scadding, "A Notice of the late Elstow Edition of Bunyan." Professor Loudon, "Acoustic Experiments."

MEMBERSHIP.

Members at the commencement of Session 1880–81		134
Members elected during the Session		8
		142
Deaths	1	
Members retired	15	
	—	16
Total Membership, March 31st, 1881		126

Composed of:

Honorary Members	2
Life Members	17
Ordinary Members	107
	126

UNITED STATES:

Annual Report of the Museum of Comparative Zoology at Harvard College.

Bulletin of the Museum of Comparative Zoology at Harvard College, Nos. 1–11.

Bulletin of the Essex Institute, Salem, Massachusetts.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1880.

Penn. Magazine of History and Biography, Philadelphia, No. 1-4, Vol. 4.

Contributions to the Geology of Eastern Massachusetts from the Boston Society of Natural History.

Proceedings of the American Antiquarian Society. Nos. 74-5.

Transactions of the Academy of Science of St. Louis.

Bulletin of the Buffalo Society of Natural Sciences.

Harvard University Library Bulletin.

Annals of the New York Academy of Sciences, 1880.

Report of the Director of Central Park Menagerie, New York, 1880.

Annals of the Lyceum of Natural History of New York.

Thirteenth Annual Report of Peabody Institute, Baltimore.

Publications of the Missouri Historical Society of St. Louis. Nos. 1-4.

Publications of the Boston Society of Natural History, part 3.

Journal of Speculative Philosophy of St. Louis, 1880.

Bulletin of the Philosophical Society of Washington. Vol. 1-3, 1880.

Annual Report of New York State Museum of Natural History, 1875-79.

Brief of a Title of the Seventeen Townships of County of Luzerne, by Henry M. Hayt, Harrisburg.

Variable Stars of Short Period, by E. C. Pickering, Cambridge.

American Journal of Science, 1880.

Journal of the Franklin Institute, 1880.

ENGLAND:

Proceedings of the Geological Society of London, No. 136-141, 1878-1880.

Proceedings of the Royal Geographical Society, London, 1880.

Journal of the Royal Microscopical Society, Vol. 3.

Quarterly Journal of the Geological Society, London.

Transactions of the Manchester Geological Society, Vol. 15 to pt. 2 Vol. 16.

List of the Geological Society of London, 1878-1879.

Annual Report of the Leeds Philosophical and Literary Society, 1879-1880.

Journal and Transactions of the Victoria Institute, 1880.

Journal of the Royal Geographical Society, London.

The Relation between Science and Religion, by Bishop of Edinburgh.

The Annealed Jaws from the Wenlock and Ludlow Formations, by G. J. Hinde, F.G.S.

SCOTLAND:

Transactions and Progress of the Botanical Society of Edinburgh, Vol. 13, part 3.

Report of Temperature, Winter 1178-1879, Edinburgh.

Transactions of Geological Society of Edinburgh, 1880.

Transactions of Royal Society of Edinburgh, 1877-8-9.

IRELAND :

Annual Report of the Belfast Naturalist Field Club.

Transactions of the Royal Irish Academy, Dublin, 1879-1880.

Scientific Progress of the Royal Irish Academy, Dublin, 1878-9-80.

Journal of the Royal Dublin Society, 1878.

Scientific Transactions of the Royal Dublin Society, 1878-9-80.

The following additions and donations have been made to the Library of the Canadian Institute during the past year :

CANADA :

The Canadian Naturalist, Montreal.

The Canadian Journal of Medical Science, 1880.

The Canadian Pharmaceutical Journal, 1880.

Journal of Education, Quebec, 1880.

Annual Report of the Entomological Society, Ontario, 1880.

Descriptive Catalogue of the Economic Minerals of Canada, Montreal, 1880.

Canadian Entomologist, 1880.

Report of Meteorological Service of Canada, 1880.

Annuaire de l' Institut Canadien, Quebec, No. 7, 1880.

Report of the Toronto Water Works, 1880.

Report of Progress Geological Survey of Canada, 1878-1879.

La Revue Canadienne of Montreal, Janvier, 1881.

FRANCE :

Memoirs de la Societé Ingenieurs Civils, 1880.

Catalogue of the National Society of Natural Sciences of Cherbourg, 1878.

Bulletin of the Geological Society of France, 1880.

Memoirs of the National Society of Natural Sciences of Cherbourg, 1877-8.

Annales Des Mines, 1879.

Eloge de M. Louis. By M. J. Beclard, 1874.

Extracts D'un Memoire sur les Moyens De Prevenir Les Dissetts par le C. A. Hugo.

TORINA :

Cosmos. By Guido Cora, for 1880.

ITALY :

Atti della Societa Toscana di Scienza Naturale, 1880.

WIEN :

Jahrbuch der K. K. Geologischen Reichsanstadt, 1879-80.

Mittheilungen der Kais. und Kon. Geographischen Gesellschaft, 1879.

Verhandlungen der K. K. Zoologisch-Botanischen Gesellschaft, 1879.

MUNCHEN :

Sitzungsberichte der K. b. Akademie der Wissenschaften, 1878-9-80.

Ignatius Von Loyola der Romischen Curie, 1879.

Meteorologische und Magnetische Beobachtumgen der K. Sternwarte bie München, 1879.

DRESDEN :

Sitzungs-Beritchte Nat. ges Gesellschaft. Isis in Dresden, 1879-80-1.

GOTTINGEN :

The Royal Association of Sciences, Naritchten, 1879.

HANOVER :

Erster Jahr't Geographische Gesellschaft zu Hannover, 1879.

INDIA :

Memoirs of the Geological Survey of India, 1879-80.

Records of the Geological Survey of India, 1879-80.

NEW SOUTH WALES :

Journal and Proceedings of the Royal Society, New South Wales, 1878.

Transactions and Proceedings of the New Zealand Institute, 1879.

MEXICO :

Annales del Museo Nacional De Mexico, 1878-80.

BONN :

Verhandelungen der Natur'chen Vereines der Prusischen Rheinland, Westfalens, 1879-80.

HAMBURG :

Association of Natural Sciences, 1880.

AMSTERDAM :

Verhandelungen der Koninklijke Akademie, Von Wetenschappen, 1879.

Verslagen en Mededulungen, der Koninklijke Akademie, Van Wetenschappen, 1879.

Jaarboek Van de Koninklijke Akademie, Van Wetenschappen, 1878.

COPENHAGEN :

Royal Danish Society of Sciences, Oversigt, part 3, 1879, part 1-2, 1880.

HARLEM :

Archives Neulandaises Sciences Exactes et Natur's : per Holland Society of Sciences at Harlem, Tome XIV-XV, 1879-80.

Archives du Musee Teyler, Vol. V. 1880.

BREMEN :

The Association of Natural Sciences of Bremen : Abhandlungen, 1879-80.

Beilage, No. 7, of Natural Sciences of Bremen : Abhandlungen, 1879-80.

PRAG :

K. K. Sternwarte zu Prag : Beobachtungen, 1879.

UTRECHT :

Meteorologisch Jaarboek, 1879.

MADRID :

Annuario de Observatorio de Madrid, 1877-8.

Resumeu de la Observaciones Meteorlogicas, 1875-8.

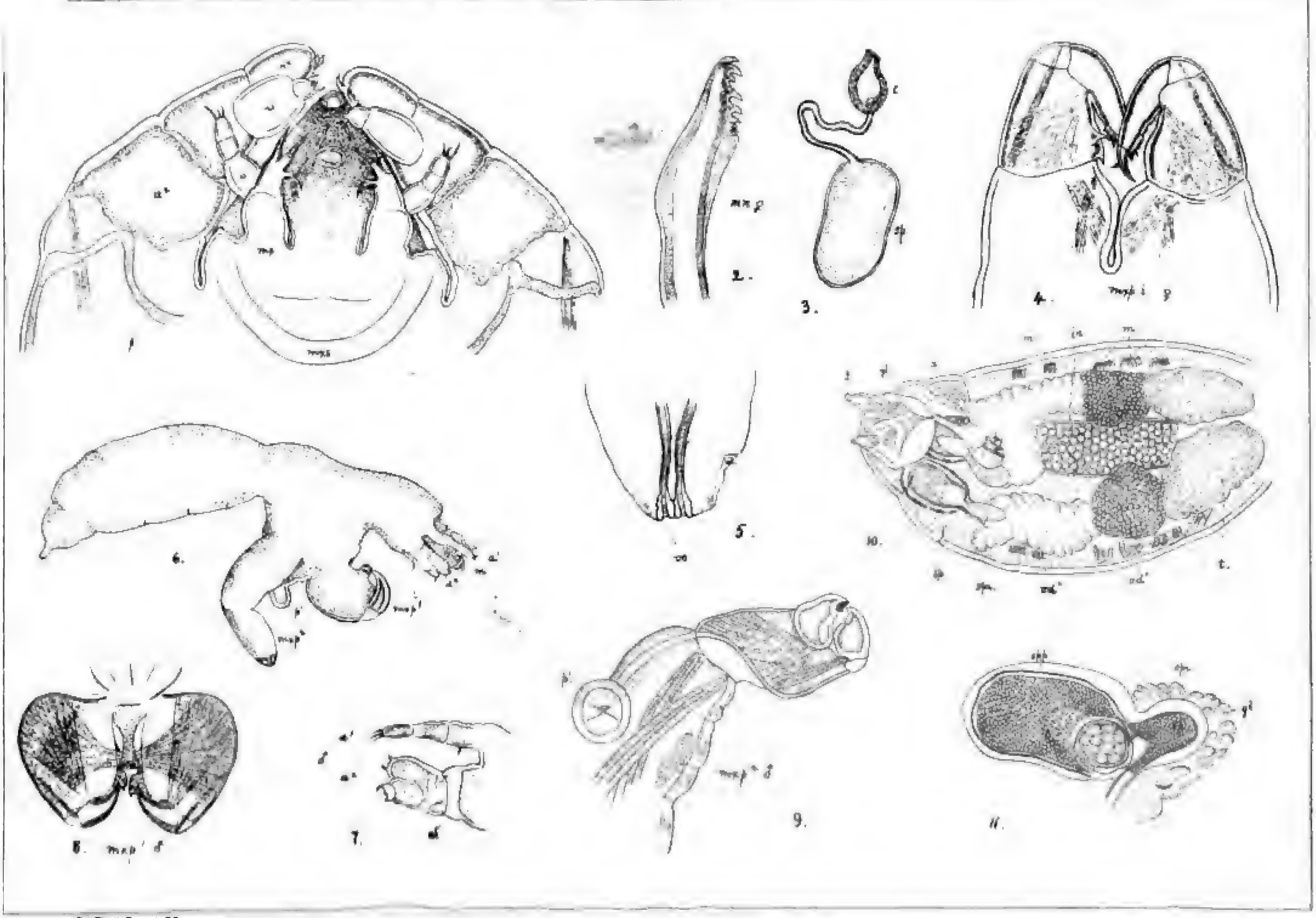
BRAUNSCHWEIG :

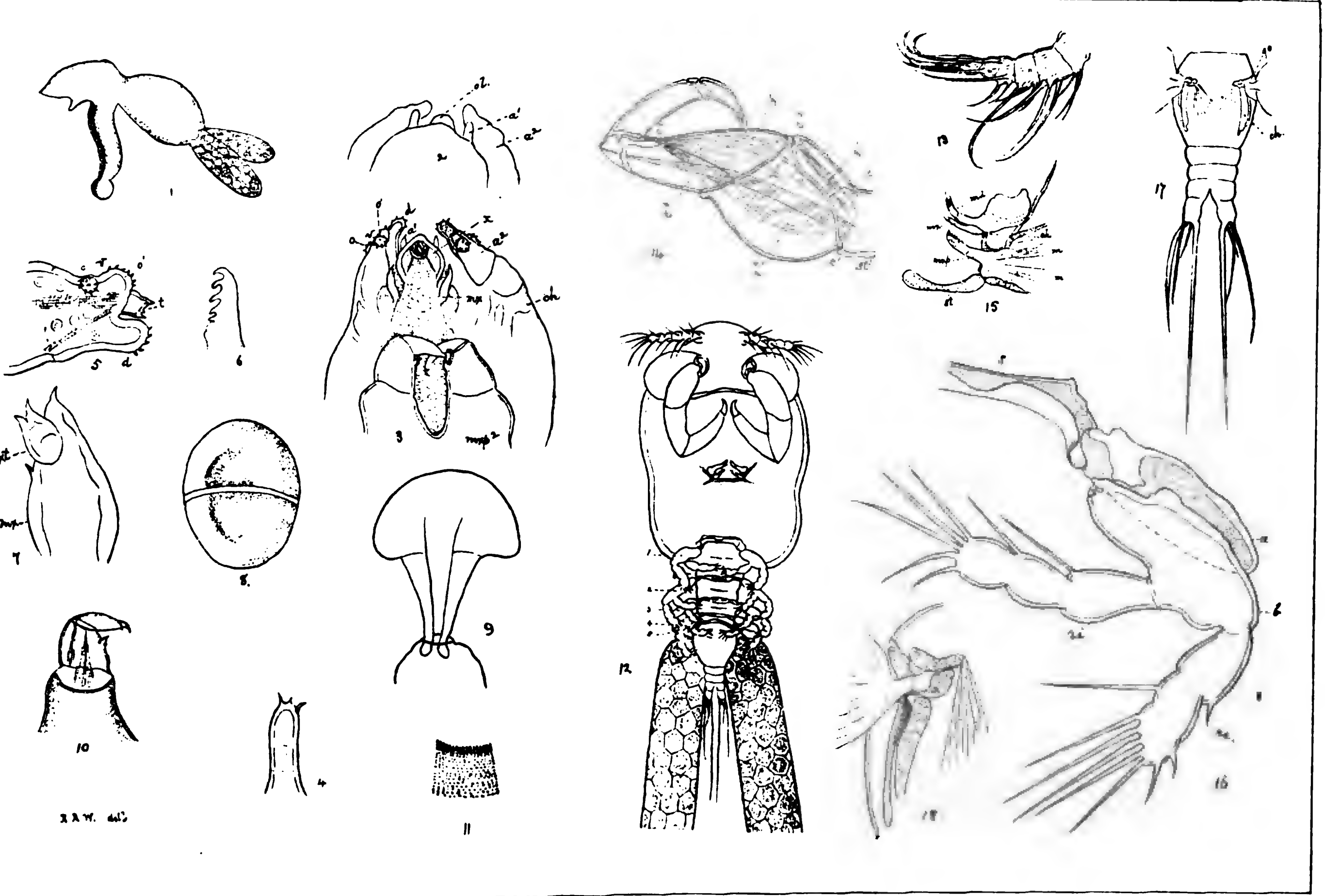
Jahresbericht des Vereines fur Naturwissenschaft, zu Braunschweig, 1879-80.

The following publications are subscribed for by the Institute :-

The Contemporary Review.
The Nineteenth Century.
American Journal of Medical Science.
Medical Science.
Hardwick's Science Gossip.
Popular Science Monthly.
Scientific American.
Scientific American Snpplement.
English Mechanic.
Nature.
Medical Times and Gazette.
Blackwood's Magazine.
London Quarterly Review.
British Quarterly Review.
Edinburgh Review.
Westminster Review.

Plate II.

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NOTES ON

AMERICAN PARASITIC COPEPODA.

No. I.

BY R. RAMSAY WRIGHT, M.A., B.Sc.

Professor in University College, Toronto.

In the course of some helminthological investigations concerning the Fresh-Water Fishes of this region, the results of which I hope to publish shortly, my attention has occasionally been attracted to Parasitic Copepoda, the careful examination of which I have hitherto been obliged to defer. The present paper has for its object the consideration of three of these forms.

I.

ERGASILUS CENTRARCHIDARUM, *n. sp.*

The gills of various members of the family Centrarchidæ are found in this neighbourhood to be infested by a small species of Ergasilus, which usually occurs abundantly on infected individuals. I have observed that the same parasite may also occur on the Perch, but it is much more commonly met with on the Rock Bass (*Amblo-plites rupestris*), the common Sun-Fish (*Eupomotis aureus*, Gill and Jordan), and the Long-Eared Pond-Fish (*Lepomis auritus* [L.] Raf.), especially on the first of the three. I have only met with female specimens.

CHARACTERS.

Length of body, exclusive of furcal bristles, ½ mm., of egg-sacs 1 mm. Cephalothorax nearly as broad as long. Median constriction barely noticeable. The longest of the antennulary bristles as long as the antennule. Mandible without palp. Basal joint of natatory limbs naked. Ramus internus of 1st pair, with single bristle on inner border of 1st and 2nd joints, and 5 terminal bristles: of succeeding pairs, with 2 bristles on the 2nd joint. Ramus externus of 1st pair with 1 spine on outer border of 1st, 2 on outer border of 3rd, and a bristle on inner border of 2nd joints: of succeeding

pairs, without the 2 spines on 3rd joint. Furcal bristles 4,—2 principal, 2 subsidiary, of which one very short.

THE APPENDAGES.—ANTENNULÆ.

One of these is represented in Fig. 13, from the posterior aspect.

They are 6-jointed, and originate on the under side of the head at some little distance from each other. There is no antennulary sternum. Of the joints the 2nd is the largest, and with its exception, the 6th the longest. All the joints bear simple bristles, the longest of which are nearly as long as the antennule itself. The bristles of the first four joints are chiefly directed downwards; of the two terminal joints backwards and outwards. Into each bristle branches of the antennulary nerve may be seen to pass.

ANTENNÆ.

As in the other species of the genus, the antennæ form strong prehensile claws by which the animal clings on to the gill-filaments of its host. The antennary sternum is well developed (Figs. 12 and 14, st.), and enters at its extremities into the construction of the hinge-joints, which the antennæ form with their sockets. The basal joint is much inflated (as in *E. gibbus* V. Nordmann) on its outer and lower aspect, while on the opposite it is strengthened by 2 chitinous ledges, which descend from the hinge between it and the succeeding joint (c^2, Fig. 14) to the socket (c^1). When viewed from the surface one of these ledges gives the appearance of a diagonal division in the basal joint.[1] The hinge between the 2nd and third joints is somewhat complicated, but its arrangement, as well as those of the chief flexor and extensor muscles entering the appendage, may be studied in Fig. 14. The terminal joint is particularly short and curved; in this respect unlike the same part in E. Sieboldii.[2]

APPENDAGES OF THE MOUTH.

These have been only satisfactorily described for *E. Sieboldii* by Claus.

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[1] Vide Olsson, Ofversigt af Kongl. Vet. Akad. Förhand, 1877, No. 5, p. 76.

[2] v. Claus Zeit. Wiss. Zool., Taf. XXIII., Fig. 14. In a revision of the species of Ergasilus, it will probably be found that apart from the size, form of body, and length of egg-sacs, the form of the appendages will afford valuable specific characters. As far as I am aware, however, Claus' figures are the only ones which possess the necessary accuracy of detail.

The parts are somewhat difficult to study in the present species on account of its small size, but the main facts elucidated by Claus are found to obtain also here. I have not detected any labrum. The basal joint of the mandible is very large, and works in a somewhat oval socket from which a chitinous ledge is continued forwards and outwards. The cutting edge is provided with several strong bristles. No palp is to be seen. The maxilla (mx., Fig. 15) is, however, more intimately attached to the mandible than in *E. Sieboldii*. That it is the maxilla, and not a mandibular palp, is shown by its articulation to a chitinous ledge continued forward from the socket of the maxillipede, and on which the basal joint of the mandible also partly rests.

The second maxillipede is absent: the first 2-jointed and armed on the anterior and inferior faces of the lower joint with short, stout bristles. The maxillipedary sternum is particularly strong.

THE NATATORY FEET.

Except in details, which I have found to be constant, and which ought to be looked to for specific characters, the present species agrees with *E. Sieboldii*. The five sterna belonging to the five thoracic somites are constructed on the same type, and are formed of 2 transverse chitinous thickenings continuous with each other at the sockets of the limbs. The sockets (*a* Fig. 16) project more or less from the surface of the body, and enter into the formation of a very free hinge-joint, with the basal segments of the limbs. These are also movably articulated to the posterior of the two sternal thickenings. The figure shows how the bristles and spines are disposed in the external and internal rami of the 1st natatory limb. The internal rami of the 2nd, 3rd and 4th pairs differ from that of the 1st in having two bristles on the second segment instead of one, while the external rami of the 2nd, 3rd and 4th pairs differ from that of the 1st in the absence of the 2 spines on the terminal segment. The basal joint is not ciliated as in *E. Sieboldii*. The natatory limbs of the fifth pair are represented by a bristle articulated to the end of the comparatively well developed sternum.

I have not been able to determine the precise function of the curious chitinous structures situated at the opening of the oviduct, and which Claus has figured much more accurately than previous authors. They are evidently developed from the lining membrane

of the terminal portion of the oviduct. Three or four short chitinous pieces situated above the opening, and connected with each other, I at first supposed to be a coiled tube similar to that described as passing in various free forms from the receptaculum seminis to the end of the oviduct.[1] But there is no trace of a receptaculum seminis in Ergasilus, and these chitinous pieces serve to form a hinge for the two longer pieces which stretch back within the segment on each side. (Fig. 18). The muscle attached to the shorter chitinous pieces may serve to abduct the egg sacs.

The furcal bristles are differently disposed from any described species of Ergasilus. I am not confident that the arrangement represented in Fig. 7 is constant, but it seems fairly common. Some variability must be assigned to these structures, as Olsson (loc. cit.) has noticed the occurrence of three in *E. Sieboldii*, and I have observed the internal (stronger) bristle bifurcated on one or two occasions.

The egg-sacs, although often unequal, are generally twice the length of the body of the female.

II.

LERNÆOPODA EDWARDSII. *Olsson.*

(Prodromus faunæ Copepodorum parasitantium Scandinaviæ. Act. Univ. Lund., 1868, p. 36.)

Prof. Osler, Montreal, obtained several specimens of a species of *Lernæopoda* from the gills of the brook trout (Salmo fontinalis), which differs markedly from the *S. Salmonea* of Baird, but agrees very well with Milne-Edwards' figure of *Basanistes Salmonea* from *Salmo umbla* (Hist. Nat. d. Crust., Tab. XLI., f. 3). In the above-cited memoir, Olsson proposes the specific name of *L. Edwardsii* for Milne-Edwards' form, and describes its characteristic features from specimens (from unknown host) in the Museum of the University of Lund. It can hardly be doubted that, at any rate, this species of *Basanistes* is a true *Lernæopoda.*[2]

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[1] Aug. Gruber, Zeit. Wiss. Zool. XXXII., p. 407 seq.

[2] Apart from the rounded tubercles on the abdomen of B. huchonis, the shortness and thickness of the "arms," and their separate attachment to the chitinous bulla, are regarded as characteristic of the genus; but the different species of Lernæopoda vary much in this respect. In the form described in the text it is easy to prepare the bulla into the halves belonging to each arm.

In size my specimens agree best with *L. Edwardsii* and *L. alpina* Olsson, but the details furnished of the latter[1] forbid their reference to this species, while on the whole they agree very well with Olsson's description of the former. This is, however, not accompanied by details of the appendages, and as Kurz observes[2] it is to these, and not to the form of the body or the angle which the "arms" make with it, that we must look for constant characters on which to ground valid species. I prefer, therefore, to describe the appendages of the present form under the above specific name, rather than attribute too much importance to the difference in shape of the chitinous bulla in Olsson's description.

The shape of the body is sufficiently indicated by the outline sketch, Fig. 1, which also indicates the hump on the cephalothorax, opposite the origin of the arms. The length of the body, exclusive of egg-sacs, is 4 mm., of the egg-sacs 2 mm. (they are probably somewhat more shrunken in proportion by their preservation in alcohol than the body), while the arms are about 2½ mm. long. The position of the 1st and 2nd pairs of antennæ, and of the projecting upper lip, in relation to the anterior border of the cephalothorax, may be seen from the outline sketch from above, Fig. 2. The 1st pair of antennæ are much more easily studied from above than from below, owing to the lateral projections from the upper lip, *x*, Fig. 3, which nearly conceal them from that aspect. They measure 0.07 mm. in length, are indistinctly 3-jointed, and bear on the rounded end of the terminal joint 3 minute spines, of which the median one is distinctly articulated to the antenna, *v*, Fig. 3. The second pair of antennæ may be most conveniently examined from below and from the side. They consist of a thick stem indistinctly 3-jointed, the basal joint being far the longest, and alone provided with a chitinous plate (*ch*, Fig. 3), and of two short branches, dorsal and ventral (*d* and *v*, Figs. 3 and 5), of which the dorsal is the longer and more internal of the two. It is composed of one joint, the rounded extremity of which is provided with numerous curved chitinous points for the most part directed inwards. The ventral and more internal branch has two joints, of which the terminal one (*t*, Fig. 5) is more palp-like than the other parts of the antenna,

[1] Ofversigt af K. Vetensk. Akad. Förhand, 1877, No 5, p. 82, Figs. 9-13.

[2] Studien über die Familie der Lernæopodiden, Zeit. f. Wiss. Zool., B. XXIX., p. 382.

while the basal one bears two discoidal chitinous outgrowths, armed with curved points, of which one is lateral, while the other is ventral, in position (o and o^1, Figs. 3 and 5).

The mandibles (Fig. 6) are 0.1 mm. in length, of which one-third belongs to the toothed portion. This differs from any of the maudibles figured by Kurz in the absence of secondary teeth.

The maxillæ (Fig. 7) are tri-articulate, the basal joint inflated on its lateral aspect, and the terminal joint ending in an outwardly-directed curved spine. The palp originates from the distal part of the second joint above a spine, and itself terminates in two sharp points. The maxillæ measure 0.095 mm. in length, of which one-half is occupied by the basal joints.

The maxillipedes of the first pair, as in the other members of the genus, originate behind the second pair, and are independent as far as their attachment to the bulla. This is best described as mushroom-shaped, and its bilateral character is as well indicated by a surface view (after the fragments of gill have been removed from it), (Fig. 8), as by the fact that it is easy to prepare separately the halves belonging to each maxillipede (Fig. 9).

The maxillipedes of the second pair measure 0.73 mm. in length, and present the typical characters described by Kurz for these appendages in other Lernæopodidæ. Their specific characters may be studied in Figs. 3 and 10.

Fig. 11 reproduces the punctated appearance presented by the border of the lower lip, which measures 0.03 mm. from its attached to its free margin; the latter has only a very narrow fringe.

On comparing Olsson's figures of *L. alpinus* with mine, it is apparent that the bulla presents considerable resemblance; the 2nd antennæ also bear a similar spiny excrescence, but have a pointed instead of a blunt ventral branch; while two chitinous appendages project between the maxillæ from the ledge uniting their basal joints. If the figure of the 2nd maxillipede is accurate, it also differs considerably in outline. The details of Milne-Edward's figure of *Basanistes salmonea* are insufficient for comparison, but the resemblance of the 2nd antennæ and the 2nd maxillipedes (3^c, 3^d, Pl. XLI. loc. cit.) is sufficiently striking to justify the conclusion that the form found on the European *S. umbla* and on our Brook Trout are

Loc. cit., Taf. V., Figs. 10, 11, 12, 13.

identical; a conclusion which is rendered more probable by the fact that the hosts both belong to the subgeneric group of the Charrs.

ACHTHERES MICROPTERI, *n. s.*

The specimens for which I have selected the above specific name were found in considerable numbers, both male and female, in the mouth cavity and on the gill-arches of the small-mouthed Black Bass *Micropterus salmoides* [(Lac.) Gill]. As far as the size of the female is concerned, and the character of its fixation in the mucous membrane of its host, it might well be referred to *A. percarum* V. Nord.; but the relatively larger size of the male, the constant downward direction of the arms, the shape of the bulla, some details of structure in the other appendages, and the cylindrical form of the egg-sacs, point to the specific distinctness of this form. I am assured by Prof. D. S. Kellicott that it is also distinct from his *A. Ambloplytis* from the mouth of the Rock Bass; otherwise I should have been inclined to suspect the identity of the two American forms. I have never met with any Achtheres in our common Perch.

The female measures on an average 4 to 4½ mm., the cylindrical egg-sacs 2½ mm. Fig. 1 represents the appendages of the head from the ventral aspect. The antennulæ are attached at some considerable distance behind the mouth: their basal joints are the longest and stoutest of the three. The internal rami of the antennæ seem to present little difference from *A. percarum*, but the ends of the external rami are furnished with toothed sickle-shaped spines.

The mandibles, Fig. 2, have 9 teeth, of which the third is the shortest of the first six, and the last three are successively smaller. The inner edges of the mandibles are sharpened into a knife-edge, which is broadest immediately behind the teeth.

The maxillæ are two-jointed—the distal joint bearing a lateral two-jointed bristle-like palp, and two terminal rami of the same character. The maxillary sternum forms a prominent fold (*mxs.*, Fig. 1), owing to the advance of its appendages in front of the attachment of the antennæ.

The internal maxillipedes are three-jointed: the basal joints are united, the second are stout and furnished with a hook on the inner side (vide left side of Fig. 4), while the third are armed with a strong terminal curved claw articulated to the joint, which on its inner aspect is further furnished with two trenchant serrated ridges.

Of the muscles which move the terminal joint, the flexors are by far the most powerful; whence the ordinary position of these joints.

The arms in length (1½ mm.), transverse wrinkles, &c., resemble those of *A. percarum*, but instead of lying in front of the head have a downward direction as in Lernæopoda. Unlike this genus there is no *continuously* chitinized bulla, and the separation of the plate which represents it from the mucous membrane is much more difficult than in that form. The plate is somewhat hollowed out on its distal surface (cup-shaped in *A. percarum* V. Nordmann), and from it radiate many fine threads of chitin, which undoubtedly are the cause of the extremely intimate coalescence with the mucous membrane. The proximal surface of the plate is strengthened by a reticulum of chitinous bars, which become narrower as they approach the margin of the plate.

I have not had the opportunity of examining any living specimens, and am thus unable to contribute anything to the further knowledge of the soft parts.

Fig. 5 represents the post-abdomen of the female before the spermatophores are attached. The two canals for impregnation open upon its extremity: their walls are chitinous, and are especially thick posteriorly. In many females the spermatophores (Fig. 3) may be found sometimes empty, with the narrow ends of their terminal capsules inserted in these orifices, while in others nothing remains of the spermatophores, except these capsules. It is in this condition that they were interpreted by Claus[1] as receptacula seminis belonging to the female; but when entire they may usually be separated without difficulty from the female post-abdomen; the greater or less ease with which they may be detached from the terminal orifices depending on the amount of cement with which they have been attached to the orifices. Occasionally the cement may be present in such quantities as to deform the post-abdomen. The mode of formation of the brown capsules and of the cement is discussed further on.

The male measures as much as 1½ mm., thus being fully one-third of the length of the female. Usually I have found the male attached to the post-abdomen of the female, occasionally further forward on the body, in one case on the arms. The appendages of the head,

[1] Zeit. wiss. Zool. XI. The similar structures of Lamproglena have been more recently (Zeit. wiss. Zool. XXI.) spoken of by Claus as belonging to the spermatophoral apparatus.

although proportionately smaller, have all the specific characteristics of the female. The antennulæ (Fig. 7) are slenderer, and the internal bristles of the basal joints more distinct, while the hooks on the external rami of the antennæ are simple, and do not present the toothed sickle-shaped form observable in the female. The strengthening chitinous plates (*ch.*, Fig. 7) are also of different form. The mandibles and maxillæ seem only to differ in size.

The peculiar form of the first maxillipedes described by V. Nordmann for *A. percarum* can also be seen here. The deep and narrow sternum of these appendages (Fig. 8), shaped somewhat like a dice box, gives origin to the powerful adductor muscles, which occupy the greater part of the cavities of the basal joints. Of the two muscles which move the terminal claw-like joint, the flexor is much the more powerful, and keeps the claw shut against the toothed chitinous outgrowth of the basal joint.

The second maxillipedes (Figs. 6 and 9) are two-jointed, the distal joint terminating in two claws, both of which are hinged to it, and which are anterior and posterior in position. The anterior shuts into the posterior, which is hollowed out to receive it. The basal joint is strengthened by a diagonal chitinous bar: it is to this that V. Nordmann refers as a "muscle of almost cartilaginous consistence." The basal joints abut against each other in the middle line, and give rise to a cylindrical structure, which forms a striking feature in the profile view of the male (Fig. 6). This is represented from the ventral aspect in Fig. 9, in which an evident orifice may be seen. This may possibly be the outlet of certain little glandular masses situated in the basal joints of the appendages (*gl.*, Fig. 9), but the want of fresh specimens has hindered a satisfactory elucidation of this organ. The glands may possibly be homologous with the arm glands of the female: whether their secretion is employed for the fixation of the male on the female I have not determined. A thorough examination of the male reproductive apparatus of the Lernæopodidæ is very desirable for the purpose of elucidating the formation of the spermatophores in the Parasitic Copepoda, as Gruber has recently done for the Free forms.[1] I regret that my alcoholic specimens have not permitted an exhaustive study of this point.

[1] Zeit. wiss. Zool. B. XXXII.

Fig. 10 represents the abdomen of the male from the ventral surface, and is intended to illustrate the position of the male reproductive organs. The testes occupy the anterior segment of the abdomen, and the 1st portion of the vas deferens is dilated by the accumulated seminal elements. The 2nd portion is convoluted and beset with glandular tissue, till it opens into the pocket containing the spermatophore in course of formation. The ripe spermatophore may be studied in Fig. 11. No indication of the canal or capsule with which the spermatophore is attached to the female can be seen at this stage. The case of the spermatophore passes by a neck-like constriction into the case of the developing spermatophore, and it is through the aperture formed by the rupture of this constriction that the contents pass out. These correspond to the three elements described by Gruber for the Free Copepoda, viz., a globular central mass, ·085 mm. in diameter, representing the axial cement in the free forms, numbers of rod-like spermatozoa (not more than 2 μ in length), occupying the greater part of the rest of the axis of the spermatophore, and lastly, the refractive polygonal discharging corpuscles (the Austreibemasse of German Zoologists).

These I have only observed in preparations taken from alcoholic specimens of the male, and I have not had the opportunity of studying the mode of fixation of the spermatophore on the female. Two kinds of cement have been described in the Free Copepoda, (1) that situated in the spermatophoral dilation of the vas deferens, which serves to fix the ejected spermatophore to the female, and (2) that in the axis of the spermatophore, and which in Canthocamptus, *e.g.*, forms a curved canal through which the spermatozoa are ejected.

That the former kind of cement exists also in Achtheres is readily seen from the pieces of it adhering to the post-abdomen of the female, and which I have referred to above as being often present in considerable quantity. It appears to be formed by the glands grouped round the lower part of the vas deferens. The second sort of cement is ejected from the spermatophore in the form of a somewhat globular mass, composed of a peripheral translucent layer with finely granular contents. It appears to me that this mass undergoes a change similar to what takes place in Canthocamptus only more complicated, viz., that after the fixation of the spermatophore to the

[1] Gruber Zeit. wiss. Zool. 32, Pl. 25, Fig. 15.

female the globular mass is extruded through the opening in the spermatophoral wall referred to above, and inserted into one of the openings of the canals through which fertilization is effected (v. o. Fig. 5): its peripheral layer then becomes indurated and brown in colour, and is then transformed into the brown capsule, while its contents are poured out to form the convoluted canal through which the remaining contents of the spermatophore pass into the body of the female. That the brown capsule acts as a sort of receptaculum seminis is also possible: because spermatozoa are to be observed in it, even after the detachment of the empty spermatophore.

DESCRIPTION OF THE PLATES.

PLATE I.

FIGS. 1-11.—Lernæopoda Edwardsii. Figs. 12-18.—Ergasilus Centrarchidarum.

FIG. 1.—Outline of body, female.

FIG. 2.—Outline of head and antennae from upper surface; *ol*, the upper lip; a^1, antennulae; a^{11}, antennae.

FIG. 3.—Ventral surface of head; *d*, the dorsal; *v*, the ventral branch of the antennae; *o* and o^1, chitinous outgrowths on the latter; *ch*, chitinous plate in 2nd joint of antenna; *mx*, maxilla; mxp^2, the internal maxillipedes, the second pair according to some morphologists.

FIG. 4.—One of the first pair of antennae.

FIG. 5.—One of the second pair of antennae from the outer side; *t*, the terminal joint of the ventral ramus.

FIG. 6.—Toothed part of mandible.

FIG. 7.—Maxilla with palp, *mxt*.

FIG. 8.—Chitinous bulla from surface.

FIG. 9.—Inner surface of one half of a bulla in connection with the arm.

FIG. 10.—An internal maxillipede.

FIG. 11.—The free border of the lower lip.

FIG. 12.—Ergasilus Centrarchidarum from ventral surface; 1—5, the natatory limbs.

FIG. 13.—The 1st pair of antennae from behind.

FIG. 14.—The 2nd pair; c^1 c^2 c^3, hinges between the various joints; e^1 e^2 e^3, extensor muscles; *f*, flexor; *st*, antennary sternum.

FIG. 15.—Mouth-parts; *mx*, maxilla; *mxp*, maxillipede; *st*, maxillipedary sternum; *mm*, muscles; *ch*, points to the chitinous bar which runs from the socket of maxillipede to the socket of the maxilla.

FIG. 16.—1st pair of natatory limbs; *s*, the sternum; *a*, the socket; *b*, the basal joint; *ri*, ramus internus; *re*, ramus externus.

FIG. 17.—Genital segment and rest of abdomen from below; *go*, genital orifice; *ch*, chitinous rods.

FIG. 18.—Attachment of egg-sac to genital aperature, showing the disposition of the chitinous rods.

PLATE II.

ILLUSTRATING ACHTHERES MICROPTERI.

FIG. 1.—Head of female from ventral surface; lettering as above.

FIG. 2.—Mandible of female.

FIG. 3.—Empty spermatophore detached from female.

FIG. 4.—Internal maxillipedes.

FIG. 5.—End of abdomen, female, to show the canals for impregnation with their orifices, *v o*, to which the brown capsules are often found attached.

FIG. 6.—Outline of male from side; *m*, the mouth; *p*, the cylindrical process from the external maxillipedes.

FIG. 7.—The two pairs of antennae of the male from the inner aspect; *ch*, the chitinous supporting plates.

FIG. 8.—First pair of maxillipedes.

FIG. 9.—Right 2nd maxillipedes from below; p^1, the cylindrical process.

FIG. 10.—Abdomen of male from below; the preparation is slightly oblique; *f*, the furcal appendages; *gl*, the glandular heaps in these; *a*, the arms; *in*, the intestine; *m m*, muscles of the abdominal wall broken; *t*, the testis; vd^1, 1st, vd^2, 2nd portion of vas deferens.

FIG. 11.—Spermatophores dissected out, the ripe one ruptured below the neck-like constriction which joins it to the developing spermatophore; the globular cement mass is emerging, behind it are the rod-like spermatozoa; the discharging corpuscles still line the wall of the spermatophore; *spp*, the spermatophoral pouch; *gl*, the glands which secrete the cement which fixes the spermatophore in the first place to the abdomen of the female.

NOTICE OF A
REMARKABLE MEMORIAL HORN,
THE PLEDGE OF A TREATY WITH THE CREEK NATION IN 1765.

BY DANIEL WILSON, LL.D., F.R.S.E.,
President of University College.

Accidental circumstances have recently brought under my notice, and ultimately led to the acquisition for the museum of the University of Toronto, of a curious relic of one of the great Indian confederacies which still maintained its influence as the colonial history of the older plantations of North America drew to a close. The date on the memorial horn now referred to carries the mind back to a period when the warriors of the Creek nation, to whom it refers, were still a powerful native confederacy; and negotiated with haughty condescension, alike with their Indian rivals, and with the representatives of the Sovereign of Great Britain. The Creek nation has not, even now, passed away. Some of the members of the confederacy still claim a share in their ancient inheritance; but in the intervening century the marvellous changes which have transpired render the historical memorial here referred to scarcely less strange than if it recorded some of the first interviews with the men of the new world by European adventurers of the sixteenth, instead of the eighteenth century.

The Creek nation is not to be confounded with the Crees of our Canadian North-west. An extensive tract of country in what now constitutes the Southern States was, in the 18th century, occupied by the Cherokees, Choctaws, Chickasaws, Catawbas, Uchees, and Muscogees. To all of those the English appear to have loosely applied the term "*Creeks.*" But the name strictly belongs to a nation formed by the union of a number of minor Indian tribes with the Muscogees, who occupied the country in the northern part of the States of Georgia and Alabama, watered by the Chatahoochee and the Flint rivers; the Alabama river forming the contested boundary

line between the Creeks and the Choctaws. The Muscogees, who were the central tribe of the powerful Creek confederacy, cherished a tradition that their ancestors first issued out of a cave near the Alabama river. De Brahm reckoned the number of the Creeks at 15,000, including women and children. They were brave and powerful warriors, shrewd and politic in their relations with outsiders; and intensely jealous of all, whether red or white men, who did not belong to their own confederacy.

De Bry, in his "*Brevis Narratio*," 1591, presents a spirited description of the Mico, or chief, and his warriors, in convention. A council meeting was opened by the cup-bearer handing to him a shell filled with a decoction of the *cassine* or *ilex yupon*. This is a powerful diuretic; and its medicinal influences were invoked to purge them from all hindrance to thoughtful deliberation. This done, all partook of it, drinking it from shells made of the large pynelæ of the Gulf. They next engaged in a solemn dance; and then, seated in the Council House, listened to the addresses of the orators and principal men among their tribes. When this was done, the Mico sprinkled them all with water, saying: "Thus may the blood of your enemies flow freely." Then he poured water on the council fire and extinguished it, exclaiming: "Thus as I extinguish the flames so may your enemies be vanquished and exterminated."

The curious relic of this ancient Indian people, which has been recently acquired for the museum of the University of Toronto, was the property of Mr. J. A. R. White, of Walkerton, Ontario; and, as will be seen, is not only an interesting memorial of colonial intercourse with one of the most powerful southern tribes upwards of a century ago; but has acquired altogether novel and romantic associations from the more recent incidents of its singular history. Its late owner served in the Royal Engineers, and, as a member of that corps, was during the terrible revolt of the Sepoys in British India. He was present, along with his company, at the siege of Lucknow, and took this horn from the body of a Sewor, or light dragoon of the Bengal mutineers, killed in a skirmish at the stone bridge at Lucknow, on the 17th March, 1857. The native Sewor, he presumes, had acquired it among the spoils of some English dwelling sacked by the mutineers. The inscription shows it to have originally belonged to a British officer; but the date carries us back upwards of a century; and so adds to the singularity of the recovery of this

curious relic of a conference with the warriors of the Creek nation in 1765, away on the opposite side of the globe, on one of the remote tributaries of the Ganges.

The style of engraving of the horn fully accords with its date. A shield, left blank, has inscribed below it:

"WILLIAM SHARP, ESQ., LIEUT. OF THE NINTH REGIMENT, 1766."

This is, no doubt, the original owner of the horn. At a table, seated under a canopy, are a group apparently of British officers, wearing the three-cocked hats of the 18th century. In front a group of Indians appears seated on the ground: with the exception of two who occupy chairs nearer the table, and smoke their tomahawk pipes. Behind the officers another group of Indians engage in a dance: and this inscription is graven below: "An Indian beloved dance performed by ye Creeks." Underneath the whole is this inscription: "The Congrass held at Picalata betwixt Governor Grant the Head Men and Warriors of the Creek Nation, November the 17th, 1765." Beneath this, in reverse, is a man shooting at a flying deer.

The horn, it may be added, appears to have been originally a powder horn. But it was cracked, and the bottom detached from it, as its late owner believed, owing to the native Sewor, from whose body he took it, having fallen on it when he received his death blow. It has subsequently been protected, as will be seen, by a silver rim placed round the lower end, so as to give it the appearance of a hunting horn.

Picalata may probably still be identified in the Picolata, a small portal town, in St. John's County, Florida. If so, it indicates the site chosen for the Congress of 1765, considerably to the south of the region occupied by the principal members of the Creek confederacy.

In Brownell's "Indian Races," and also in Drake's "Biography and History of the Indians of North America," notices occur of Colonel James Grant—the same person, in all probability, as is named on the inscribed horn as Governor Grant. French emissaries were busy fomenting strife, and exciting the Indians of Carolina against the English. At a grand conclave of the Cherokee nation in 1760, Latinac, a French officer, stepped out and drove his hatchet into a log, calling out: "Who is the man that will take this up for

the King of France." Saloné, a young warrior of Estatoc, laid hold of it and cried out: "I am for war! The spirits of our brothers who have been slain still call upon us to revenge their death. He is no better than a woman who refuses to follow me." It was immediately after this event that Col. Grant assumed command of the British forces in Carolina. Brownell says:

"In the following spring (*i.e.* in 1761), Col. James Grant, who had succeeded to the command of the Highlanders employed in British service in America, commenced active operations against the belligerent nation—the Cherokees. What with the aid of the Provincials and friendly Indians, he was at the head of about twenty-six hundred men. The Chickasaws and Catawbas lent some assistance to the English; but the Creeks are said to have alternately inclined to the French or English, according as they received or hoped for favours and presents.

"The army reached Fort Prince George on the 27th of May (1761), and there old Attakullakulla, a Cherokee chief who had been long the fast friend of the English, made his appearance, deprecating the proposed vengeance of the whites upon his people. He was told that the English still felt the strongest regard for him individually, but that the ill-will and misconduct of the majority of the nation were too palpable and gross to be suffered to go longer unpunished. Colonel Grant marched from the fort in the month of June. The Cherokees made a desperate but unavailing stand; they were routed and dispersed, leaving their towns and villages of the interior to be destroyed by the invaders. Etchoe was burnt on the day following the battle. . . . Upon the return of the army to Fort Prince George, after this campaign, Attakullakulla again visited the camp, bringing with him a number of other Cherokee chiefs. Broken down by their disastrous losses, and disgusted with the deceitful promises of the French, they gladly acceded to such terms as Col. Grant thought fit to impose, and a treaty of peace was formally concluded."

Drake, in referring to the same campaign against the Indians of Carolina, says:

"Such was the condition of the country that a second application was made to General Amherst for aid, and he promptly afforded it. Colonel James Grant arrived there early in 1761, and not long after took the field with a force of English and Indians, amounting to

about 2,600 men. He traversed the Cherokee country, and subdued that people in a hard fought battle near the same place where Col. Montgomery was attacked the year before. It lasted about three hours, in which about 60 whites were killed and wounded. The loss of the Indians was unknown. Colonel Grant ordered his dead to be sunk in the river, that the Indians might not find them to practice upon them their barbarities. He then proceeded to the destruction of their towns, 15 in number, which he accomplished without molestation. Peace was at last effected by the mediation of Attakullakulla."

After this date, 1762, it is said: "Affairs looked peaceable and prosperous for some years." The natives made over a large additional tract of land to the growing colony of Georgia. The date, 1765, does not appear. But in 1767, there was temporary trouble, settled by Governor Wright at Savannah. The Creeks occasioned this trouble, having seized, or stolen, as it was said, some horses found on their territory belonging to the whites.

It thus appears that, at the date of the Congress named on the curious memorial horn, which perpetuates its graven record of the incidents of a conference with the Creek nation on the 17th November, 1765, the Creeks and other nations of the great Muscogee confederacy were being stirred up to war against the English, chiefly through the machinations of their French rivals. In 1761, Colonel James Grant was appointed by General Amherst, the Commander-in-Chief, to conduct the military operations in Carolina against the belligerent Indians; and to him, it may be assumed, was thereafter entrusted the civil, as well as the military, conduct of affairs in the extensive southern region occupied by the Indian nations of the Muscogee confederacy. The southern Indians were old enemies of the Iroquois, the staunch allies of the English against the French on the St. Lawrence; and were the more easily stirred up to attack the English settlers in Virginia and the Carolinas. But James Adair—a trader long resident among the southern Indians—in a "History of the American Indians," published by him in 1775, ascribes their inveterate hostility to the English to their crediting to the machinations of the latter the introduction of the small-pox. When South Carolina was first settled, he says: "The Catawbas were a numerous and warlike people, mustering about 1,500 warriors, but small-pox and the use of ardent spirits reduced them to less than

a tenth of their former numbers." And he describes a waste area seven miles in extent, still showing the traces of cultivation once carried on by them throughout its whole extent. In 1738, nearly half of the Cherokees perished by the small-pox; but the Creeks early recognized the necessity of isolating those attacked by the disease; and so, to a large extent, escaped the decimating influence of this terrible scourge.

The Indians of the Six Nations still preserve at Tuscarora, on the Grand River, the Silver Communion Service brought with them from the old home of their most warlike tribe, in the Mohawk Valley, of the State of New York, and which bears the inscription:

"A. R. 1711. The Gift of Her Majesty, Ann, by the Grace of God, of Great Britain, France, and Ireland, and of Her Plantations in North America, Queen: To Her Indian Chappel of the Mohawks."

This singularly interesting memorial is of earlier date, and associated alike with a race peculiarly identified with Canadian history and with its royal donor. Nevertheless the Picalata horn may be fitly classed with the Silver Communion Plate "of the Indian Chapel of the Mohawks," as a historical memorial of incidents otherwise lost sight of, and of a representative Indian nation now disappearing from the scenes where little more than a century ago it treated on proud equality with the representatives of the British Crown.

THE MAGNETIC IRON ORES

OF VICTORIA COUNTY,

WITH NOTES ON CHARCOAL IRON SMELTING.

BY W. HAMILTON MERRITT, F. G. S., Assoc. R. S. M., &c., &c.

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During the past summer I was called upon to make a general report of the iron occurrences in the vicinity of the Victoria Railroad, and I now have much pleasure in bringing to your notice, in a condensed form, the result of my investigations.

The Miles Location, or Old Snowdon Mine, has received notice at the hands of Prof. Chapman in a report published in 1874, therefore the general character of the ore will be known to some of you.

The Victoria Railroad, as you know, runs from Lindsay to Haliburton, some 55 miles. A short distance north of Lindsay a branch was built by Mr. Miles, which runs in a westwardly direction to his iron location, six miles from the main line. I shall now briefly refer to the GEOLOGICAL OUTLINES, which I do not think have been previously recorded.

Going north from Lindsay, several escapements of horizontal beds of Silurian Limestone are passed through. On crossing the Burnt River, after leaving Fenelon Falls, an outcrop of Granite appears on west side of the Railroad. Some compact limestone, approaching a marble in texture, which takes a good polish, and a bed of lithographic stone, are passed in cuttings near Felly's Bridge.

The crystalline rocks come in between Felly's Bridge and Kinmount (at which place they are well defined), but owing to the overgrown condition of the country, it was impossible to note their junction.

The crystalline rocks belong to the Laurentian Series, the strongest iron carrying rocks in our country. Their strike here, as is general, is about N. N. E. and S. S. W. and dip about 40 % E.

They consist of alternating granite, gneiss, syenite and crystalline limestone, with occasional bands of dioritic rocks, which, however, are not so strongly developed in this as in the Madoc region.

The occurrence of labradorite rock or norite, which is found at the Miles Location, and titaniferous iron beds, which occur at Pine Lake and other places, would seem to point to the norian or upper laurentian of Logan, but there is not a universal enough development to justify such a conclusion.

To the East of Kinmount the gneiss is replaced by crystalline limestone, in which rock the Victoria, or Old Snowdon, mine occurs. Continuing Eastward, between the Victoria mine and the Howland and Ledyard locations, the road is very circuitous, and not on the map, therefore my observations of the rocks might be misleading as to their actual occurrence. Halfway between the Snowdon and Ledyard locations, quartzite and a fine grained pinkish syenite take the place of limestone. The crystalline limestone appears again before arriving at the Ledyard location, and continues westward beyond the Howland property further than I went.

In the Ledyard property there is a band of dioritic rock (doleritic in places), in which are the iron occurrences found in that property.

Coming back to Kinmount, and then going in a westwardly direction, the gneiss is replaced by a band of crystalline limestone a mile wide, which again is immediatety succeeded by gneiss and syenite.

Not far from the limestone the Paxton mine is in a syenite gneiss, with narrow beds of crystalline limestone occuring in places both above and below the ore

From Kinmount North the general character of rocks is precisely the same as already mentioned, granite, gneiss, syenite and crystalline limestone. The geological features of that part of the country which I saw are precisely the same as the Madoc region, with the exception of a stronger development of the dioritic ridges in the Madoc region.

In this district, hornblendic pyroxenic rock and crystalline limestone are, as a rule, associated with the iron ore. In the Madoc district the Hæmatite mine is an example of the intimate connection of the iron ore with crystalline limestone, while the Seymore mine is an example where that rock is wanting.

From the accumulation of instances, however, it would seem that in searching for iron ores, especially in the Victoria district, it would be well to keep in the vicinity of the bands of crystalline limestone, for as a rule the ores occur both in it and near its junction with granite, hornblendic and pyroxenic rocks.

I understand it to have been shewn by Mr. Vennor, in his investigations in Hastings, that the iron deposits occur in defined belts, which can be traced for long distances. My investigation in Victoria unfortunately was of too local a character to enable me to establish the continuity of the ore deposits, but it seems probable that in Snowdon Township the deposits are not merely local, but that a belt can be followed from Lot 20 in the I. Concession as far as Lot 30 in the V. Concession, a distance of 3 miles, including five locations, or possibly further in the same direction.

In Sweden the mineral bearing horizons can be followed, having the same direction as the encasing rocks, and fresh masses of mineral will be met with at intervals for dozens of kilometers, and each bed generally consists of several parallel beds separated by rock more or less barren.

In the famous Dannamore district the magnetite occurs in an irregular belt of a mile and a half in length, embedded in crystalline limestone, and it has been mined to a depth of more than 600 feet.

The iron occurrences that came under my notice bear the character of beds deposited with the enclosing rocks, the lie both of the ore bed and the intercalated minerals being the same as that of the country rock.

The Victoria mine would seem an exception, as the strike of the bed is 42 % N. W. and S. E., being nearly at an angle of 45 % to the general strike of the rocks of the country ; but it is possible that a fault running through the valley immediately to the N. W. may have altered the strike of the ore deposits, especially as at the edge of the valley, close to which the mine has been opened, there is evidence of much disturbance.

I shall not inflict you with the detailed description of the various mines in operation, and undeveloped locations that I was obliged to include in my report.

I shall simply give the result of a number of analyses from specimens I obtained at the mines, which shew, firstly, the richness of selected ore, which is better than the average shipped to the United States ; secondly, the average ore without close selection ; and thirdly, the ore that has been thrown on the dump as too poor to ship to Bessimer works.

The ore varies in texture from crystalline magnetite, with small crystals and an open texture practically free from sulphur, as found

at the Paxton mine in Lutterworth, or a closer grained magnetite carrying a certain amount of pyrites, as is seen in the Snowdon occurrences, to a compact crystalline ore containing more or less titanium, such as is found at Pine Lake and other places.

In all cases the analyses of the picked specimens were practically the same, about 60 % metallic iron, and practically free from phosphorus, sulphur and titanium.

The average samples of ores from the Snowdon properties, which would represent the character of the Victoria, Miles, Ledyard and Howland, is the following :

Silica	21.20
Oxides of Iron	66.28
Alumina	3.70
Lime	5.04
Magnesia	2.19
Sulphur	1.64
Phosphoros	.02
Titanium	.00
	100.07
Metallic Iron	48.00

These would require thorough calcining to remove the sulphur. At the Howland mine it was calcined very roughly in large pieces in heaps of 100 tons, but as samples of the calcined ore which I obtained shewed the same amount of sulphur as the raw ore, the present system of calcining is practically useless.

Average ore from the Paxton mine in Lutterworth analysed :

Oxides of Iron	67.77
Silica	19.30
Alumina	6.24
Lime	3.81
Magnesia	3.38
Sulphur	.03
Phosphorus	None.
Titanium	.15
	100.68
Metallic Iron	48.64

This ore has the decided advantage of being so free from sulphur that it would not require calcining.

The third class of samples I collected and mentioned as taken from the dump, shewed that waste ore contained over 30 % metallic iron.

There is a good deal of hornblend intimately mixed with these ores. Microscopic examinations shewed a little more free silica in the Paxton than the other ores.

The minerals occurring with the ores in this district are calcite, hornblend, actinolite, augite, felspar, mica, iron pyrites, quartz, and I found specimens of olevine, scapolite and serpentine.

To obtain a true estimate of the value of the above ores, we will consider those of Sweden which most closely resemble them, and which are at the same time recognized as equal to any in the world.

In a very interesting pamphlet on the actual state of the iron industry in Sweden, written in 1878, by Richard Akerman, Professor at the School of Mines of Stockholm, and one of the best known metallurgists of the day, a very great number of analyses of Swedish iron ores are given, nearly 800. The average ore as shewn by these contains from 45 to 50 % metallic iron, and the majority requires calcining to remove the sulphur. Mr. Akerman states that some calcareous ores, especially useful for mixing with the silicious ores, are mined as low as 20 % iron. This pamphlet also tells us that in Sweden, with a smaller population than ourselves, 484 mines were worked in 1876, from which 787,950 tons of ore were raised. From the above facts it is evident that our magnetic iron ores are equal in composition to the celebrated Swedish ore, and they are similar in occurrence. Therefore, notwithstanding the fact that it does not pay to ship under 50 % metallic iron to the United States, the majority of Swedish ore would be excluded- -by which fact we can rest assured that our magnetic iron ores must soon be much more extensively worked; which, with the aid of the diamond borer for exploration and steam mills, will, without doubt, be most successfully accomplished.

The Cleveland and Pittsburg smelters are looking about most anxiously for new supplies of ores, as those from Lake Superior are becoming very expensive. They are even meditating opening up part of West Virginia with a Railroad 300 miles long, to get at a low grade ore. We have the advantages to offer them of better ore and cheap return freight in coal vessels to Cleveland.

A few words on the question of iron smelting with charcoal I thought would not be amiss in connection with this paper.

It is needless to mention there is no industry that is of such importance to the prosperity of a country as the smelting of iron ; England is of course the most striking example of this. Were it not for her smelting works the United States would not have the balance of her commerce on the export side.

Concomitantly with the present great prosperity in France, her iron industries have taken most gigantic strides.

Belgium, Germany, Sweden, and even Russia, are examples of the great benefits which accrue to countries from the encouragement of iron smeltimg.

In Ontario it is a question whether we could smelt with mineral fuel, without a high protection.

It seems very probable that smelting with charcoal can be carried on with profit in those parts of the Province where iron ore, large quantities of timber, Railroad facilities and good water power are combined.

These essentials are united in the Victoria district. As before mentioned, the standard required in the ore to be shipped to the United States is such a very high ore that a seriously large proportion of good ore is left as a waste product.

In the vicinity of the iron mines in Victoria County, there are large tracts of woods which have been partially culled of the choicest timber, yet enough remains for the manufacture of charcaal for a long time to come. In lumbering, the branches and tops of the trees are left; these make excellent charcoal. Therefore a smelting works would prevent great waste both of the mine and forest. Settlers would soon find the burning of charcoal a handsome .little perquisite.

One point in locating a works is important, and that is unless there is in any deposit a proved quality of ore in sight, it would be very dangerous to risk the supply of a works to one deposit, as the deposits vary much in size; but the smelting works should be in a position to tap the production of several proved deposits.

In Sweden it is common to combine a saw mill with iron smelting works, as the refuse is made of much use in producing gas for the regenerative furnaces.

The cost of erection of a plain but substantial plant, with charcoal furnaces, to turn out 100 tons (minimum) per week, would be probably $60,000. With Whitewell hot blast stoves, Westman calcining

kilns, and expenses connected with water power and other details, the total cost would reach the neighbourhood of $100,000.

As regards the production of charcoal iron. In 1880 the United States produced 537,558 gross tons of charcoal pig iron from 151 blast furnaces, and in 1879 Sweden 336,176 gross tons of pig iron from 182 blast furnaces.

In 1880 France turned out 66,330 tons of charcoal pig, and 29,148 tons with coke and charcoal mixed. Styria, Carinthia, Carniola, Austrian Tyrol and Saltzburg produced in 1874 collectively 217,400 tons, and Russia in 1879 produced 429,865 gross tons of pig iron, mostly with charcoal and magnetite as the ore. We might say that about two million tons of iron are produced from charcoal per annum.

In Austria, two parts of compressed peat and one of charcoal are used at Vordernberg. Smelting by lignite has at last been successfully accomplished in the latter country. This question is of vital importance to our North-West territories.

I will close by finally stating that the question of charcoal smelting is one worthy of attention, and our local government would do well to have a thorough report made upon the subject.

CANADIAN INSTITUTE.

REPORT OF THE COUNCIL FOR 1881–82.

In presenting this their 33rd Annual Report, the Council of the Canadian Institute are happy to be able to state that the progress of the Institute during the last Session has been upon the whole satisfactory.

One important change has been successfully made in reverting to the old weekly meetings, instead of only on alternate weeks, and it is satisfactory to be able to report that the meetings have been well attended, and many interesting papers have been read by the members. There is, however, still room for improvement in that respect, and the Council sees no reason to doubt that in the next Session, when the members have become more used to the new arrangement, there will be a further increase of attendance, and more readiness in bringing interesting communications before the meetings.

Another arrangement of some importance has been accomplished, namely, that the use of our building and library has been extended to the Natural History Society, thus giving some aid and encouragement to a Society having similar objects with our own, and at the same time making the advantages of our Institute more generally known.

Another important transaction has been the sale of about 30 feet of the vacant land on the western side of our building, thus enabling us to reduce our mortgage debt by nearly one-third, with a proportionate decrease of the interest payable; and we are not without hopes that an arrangement may be made to reduce the rate of intetest now paid. This will probably enable us to enlarge the publication of our transactions, which would add very materially to the utility of the Canadian Institute.

The Treasurer's reports, the papers communicated at the meetings, the additions to the library, and the present condition of the membership, are, as usual, appended.

All which is respectfully submitted.

JOHN LANGTON, *President.*

MEMBERSHIP.

Members at the commencement of Session, 1881–82	126
Members elected during the Session	17
	143
Deaths	4
Total Membership, March 31st, 1882	139
Composed of:	
Corresponding Member	1
Honorary Members	2
Life Members	17
Ordinary	119
	139

REPORT FROM TREASURER FOR SESSION OF 1881-82.

I submit accounts shewing the financial condition of the Canadian Institute, and consider further comment unnecessary.

Summary of Current Account to 31st March, 1882.

To balance in hands of Treasurer	$511 33
" Cash from Sale of Land	1,588 75
" Cash from Annual Subscriptions	294 00
" Subscriptions to Building Fund	158 00
" Life Membership	25 00
" Rent from Warehouse	60 00
" Rent from Medical Society, Toronto	50 00
" Rent from Natural History Society	7 50
" Journals, &c., sold	4 75
" Cash due to Treasurer	133 75
	$2,833 08

By Principal on Mortgage	$1,589 00
" Interest on Mortgage	350 00
" Salary to Librarian	336 00
" Printing Journal	152 13
" Fuel	86 93
" Periodicals	80 55
" Advertising	67 00
" Insurance	42 50
" Commission on Sale of Land	39 72
" Water	24 00
" Gas	12 43
" Taxes	10 94
" Express charges	10 82
" Postage and Telegrams	8 92
" Contingencies	7 85
" Repairs	6 79
" Engrossing	5 00
" Law expenses	2 50
	$2,833 08

We certify to have examined the vouchers and the addition, which we find correct. The balance due the Treasurer being one hundred and thirty-three dollars and seventy-five cents.

JAMES BAIN, jun., } *Auditors.*
G. KENNEDY, }

24th April, 1882.

BUILDING FUND ACCOUNT.

To Amount at last Audit	$1,347 00
" Subscription from R. Wilkes	100 00
" " Copp, Clark & Co.	30 00
" " Prof. R. R. Wright	10 00
" " T. Kirkland	6 00
" " Dr. Ellis	10 00
" " N. Cawdry	2 00
	$1,505 00
" Sale of 30 feet of Land	1,588 75
	$3,093 75
By Amount due on Mortgage	$5,000 00
" Amount paid on Mortgage	1,589 00
" Amount now due and bearing interest at 7 per cent.	$3,411 00

ASSETS AND LIABILITIES.

Assets.

Canadian Institute Building	$11,000 00
" " Warehouse	720 00
" " Ground	2,500 00
" " Library	5,000 00
" " Specimens	1,200 90
" " Personal Property	400 00
	$20,820 00

Liability.

Amount due by Mortgage	$3,411 00

JOHN NOTMAN,
Treasurer.

COMMUNICATIONS.

The following valuable and interesting papers and communications were read and received from time to time at the ordinary meetings held during the Session 1881-2:

May 14, 1881.—Annual Report and Election of Officers. C. Carpmael, M.A., exhibited and explained the photographic curves from the instruments during the magnetic storm on the 11th, 12th and 13th days of August, 1880, and also of the storm on the 31st January, 1881.

October 29, 1881.—Inaugural address by the President.

November 5, 1881.—Rev. Dr. Scadding, on "The Dethronement of Latin in the Modern Scholastic World," being a continuation of "A Boy's Books, Then and Now."

November 12, 1881.—Prof. R. Ramsay Wright, B.Sc., on "A Cell and its Parasites."

November 19, 1881.—Dr. W. H. Ellis, M.A., on "The Water Supply of Toronto."

November 26, 1881.—Dr. Covernton, on "State Medicine: Ancient, Medieval, and Modern."

December 3, 1881.—John Notman, Esq., "Remarks on the origin of Numerals.' Paper on "The Genesis of Worlds."

December 10, 1881.—A. Elvins, Esq., on "The Lunar Surface," illustrated by photographs and drawings.

December 17, 1881.—W. Hamilton Merritt, F. G. S., on "The Magnetic Iron Ores of Victoria County," with notes on Charcoal Iron Smelting.

January 14, 1882.—Rev. Professor Campbell, M.A., on "Deciphering Hittite Inscriptions."

January 21, 1882.—Rev. R. Von Pirch, on "Linguistic Studies."

January 28, 1882.—John Langton, M.A., on "Popular Errors and Prejudices."

February 4, 1882.—Dr. J. Workman, on "The Origin of the English Language," with a translation of a Danish poem.

February 11, 1882.—Rev. Dr. MacNish, LL.D., "Are the Poems of Ossian of Scottish or of Irish origin?"

February 18, 1882.—J. M. Buchan, M.A., on "The proportions of the Constituents of the English Language."

February 25, 1882.—Dr. Daniel Wilson, L L.D., on "Incidents illustrative of the changes wrought on the native Indian tribes from the practice of adoption."

March 4, 1882.—C. A. Herschfelder, Esq, on "The manners and customs of the aboriginal Americans."

March 11, 1882.—Dr. P. H. Bryce, M.A., on "Hypnotism and its Phenomena."

March 25, 1882.—Dr. Jos. Workman, "Is it true that the Celtic languages have contributed but little to the English and its affiliated languages?"

April 1, 1882.—Notes on "Vapour Tension and Specific Heat," by W. J. Loudon, B.A.

April 22, 1882.—W. Brodie, Esq., on "Canadian silk producing Moths."

ADDITIONS AND DONATIONS TO THE LIBRARY OF THE CANADIAN INSTITUTE RECEIVED FROM APRIL 1ST, 1881, TO MARCH 31ST, 1882.

CANADA:

The Revue Canadienne, Montreal, 1881.

The Canadian Naturalist, Montreal, No. 1, Vol. X.

The Canadian Journal of Medical Science, 1881.

The Annual Report of the Entomological Society, 1881.

The Canadian Entomologist.

CANADA—(*Continued*).

Report of Progress Geological Survey of Canada, 1880-1881.
Report of Meteorological Service of Canada, 1881.
Pamphlet on the adoption of a Prime Meridian to be common to all Nations, by Sandford Fleming, Esq., C. M. G. (the author).
Report of the Historical and Scientific Society of Manitoba, 1882.
Report of the Superintendent of Education, Quebec, 1881.
Transactions of the Literary and Historical Society, Quebec, 1881.
Statutes of Ontario, 1881.

ENGLAND:

Proceedings of the Geological Society of London, 1881.
Proceedings of the Royal Geographical Society, 1881.
Index and Journal of the Royal Geographical Society, 1881.
Journal of the Royal Microscopical Society, 1881.
Quarterly Journal of the Geological Society, London, 1881.
Journal of the Anthropological Institute, London, 1881.
Transactions of the Manchester Geological Society, 1881.
Transactions of the Cambridge Philosophical Society, 1881.
Proceedings of the Cambridge Philosophical Society, 1881.
Transactions of the Victoria Institute, 1881.
Report of the Leeds Philosophical and Literary Society, 1881.
Southern Skies, by H. E. Lieut.-General Sir J. H. Lefroy, C. B.
Catalogue of the Library of the Royal Geographical Society, 1871.
Pamphlets on Free Trade and Protection, London.
Rainfall and Climate of India, by Sir Joseph Fayrer, K. C. S. I., F. R. S.
Financial Reform Almanack, 1882.
Proceedings of the Manchester Literary and Philosophical Society, 1879.
Memoirs of the Manchester Literary and Philosophical Society, 1879.
Trubner's Literary Record, 1881.
Minutes and Proceedings of the Institute of Civil Engineers, 1880-81.

SCOTLAND:

Transactions of the Edinburgh Geological Society, 1880 and 1881.
Transactions and Proceedings of the Botanical Society, 1881-82.
Proceedings of the Royal Society of Edinburgh, 1879-80.
Proceedings of the Philosophical Society of Glasgow, 1879-80.
Transactions of the Royal Scottish Society of Arts, 1881.
Proceedings of the Royal Physical Society, Edinburgh, 1879-80.

IRELAND:

Transactions of the Royal Irish Academy, Dublin, 1880-81.
Proceedings of the Royal Dublin Society, 1881.
Transactions of the Royal Dublin Society, 1881.
Journal of the Royal Geological Society of Ireland.

INDIA:

Records of Geological Survey of India, 1880-81.
Memoirs of Geological Survey of India, 1880-81.
Memoirs of Geological Palæoritologia Indica, 1880.

NEW SOUTH WALES:

Reports of the Council of Education, 1879.
Journal and Proceedings of the Royal Society, 1879-80.
Annual Report, Department of Mines, for 1878-9.
Maps, Department of Mines, for 1878-9.
Report upon certain Museums, by A. Liversidge, 1880.

NEW ZEALAND:

Transactions and Proceedings of the New Zealand Institute, 1880.

TASMANIA:

Proceedings and Report of the Royal Society of Tasmania, 1880.

UNITED STATES:

The Names of the Gods in the Riche Myths, Central America, by D. G. Brinton, M.D.
The American Journal of Science, 1881.
The Journal of the Franklin Institute, 1881.
Proceedings of the American Antiquarian Society, 1881-2.
Transactions of the Academy of Science of St. Louis, 1880.
Anniversary Memoirs of the Boston Society of Natural History, 1830-80.
Transactions of the New York Academy of Sciences, 1881-82.
Bulletin of the Buffalo Society of Natural Sciences, 1881.
Annals of the New York Academy of Sciences, 1881.
Report of the New York State Museum of Natural History, 1879.
Records of the Proprietors of the Worcester Society of Antiquaries, 1881.
The Philadelphia Magazine of History and Biography, 1881.
Proceedings of the Academy of Natural Sciences of Philadelphia, 1881.
Journal of Speculative Philosophy, by W. T. Harris, 1881.
Bulletin of the Museum of Comparative Zoology, Cambridge, 1881.
Report of the Museum of Comparative Zoology, Cambridge, 1880-81.
Proceedings of the Worcester Society of Antiquity, 1881.
Proceedings of the Boston Society of Natural History, 1881.
Memoirs of the Boston Society of Natural History, 1881.
Report of the Comptroller of the Currency, 1880.
Library Bulletin of the Harvard University, 1881.
Bulletin of the Essex Institute, 1881.
Visitors' Guide to Salem. H. P. Iives, Publisher.
Annual Report of the Peabody Institute, Baltimore, 1881.
Report of the New York State Library, 1880.
Bridgeport Scientific Society, Annual Address by President N. H. Powers, D.D., 1881.
Memoirs of the Peabody Academy of Science, Salem, 1881.

AUSTRIA:

Koniglich bohmische Gesellschaft der Wissenschaften, Prag, 1879-80.
K. K. Sternwarte zu Prag. Beobachtungen, Prag, 1879-80.
K. K. Geographische Gesellschaft, Vienna, 1879-80.
K. K. Zoologisch-Botanische Gesellschaft, Vienna, 1880.
K. K. Geŏlogische Reichsanstadt, Vienna, 1880-81.

BELGIUM :

Academie Royal des Sciences, des Lettres, et des Beaux Arts, Brussels, 1878-9-80.

DENMARK :

Academie Royal des Sciences, Copenhagen, 1880-81.

FRANCE :

Societé Nationale, des Naturales Sciences, Cherbourg, 1879.
Societé Geologique De Normandie, Havre, 1879.
Societé Ingenieurs Civils, Paris, 1881.
Societé Geologique, Paris, 1880.

GERMANY :

Naturhistorischer Verein der Preussischen Rheinlande und Westphalens, Bonn, 1881.
Naturwissenschaftlichen Vereins zu Bremen, Bremen, 1880-81.
Nat. ges. Gesellschaft. Isis in Dresden, Dresden, 1881.
K. Gesellschaft der Wissenschaften, Gottingen, 1881.
Naturwissenschaftlichen Verelns von Hamburg-Altona, Hamburg, 1881.
Geographischen Gesellschaft zu Hannover, Hannover, 1879.
Die Physikalisch-Okomische Gesellschaft, Konigsberg, 1876-80.
Konigliche Akademie der Wissenschaften in Munchen, Munchen, 1880.
Der K. Sternwarte bie Munchen, Munchen, 1881.

ITALY :

Del Re Instituto Di Studi Superiori e Di Perfezionamento in Firenze, Florence, 1880-81.
Societé Toscana Di Scienza Naturale, Pisa, 1881.
Cosmos. Di Guido Cora, Torino, 1881.

MEXICO :

Museo Nagional De Mexico, Mexico, 1880-81.

NETHERLANDS :

Koninklijkf Akademie Van Wetenscappen, Amsterdam, 1879-80.
Secieté Hollandaise Des Sciences à Harlem, Harlem, 1880-81.
Archives Du Musee Teyler, Harlem, 1879-81.
Koninklijk Nederlandsch Meteorologisch Iustitut, Utrecht, 1879-80.

SWEDEN :

Kongliga Svenska Vetenskapo-Akademie, Stockholm, 1876-81.

Fig. 1.

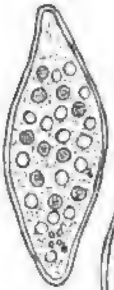


Fig. 2.

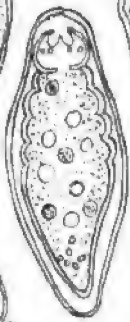


Fig. 3.

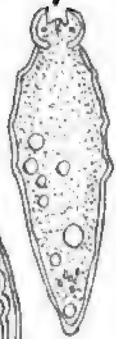


Fig. 4.

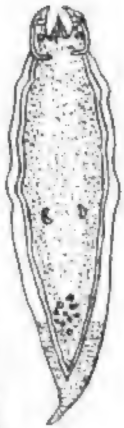


Fig. 7.

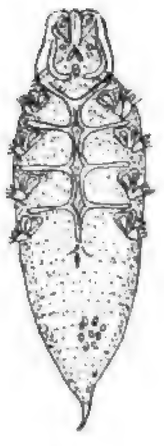


Fig. 8.

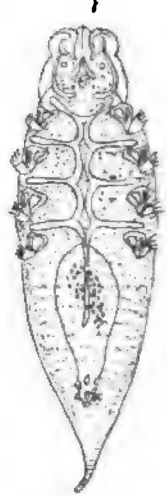


Fig. 5.

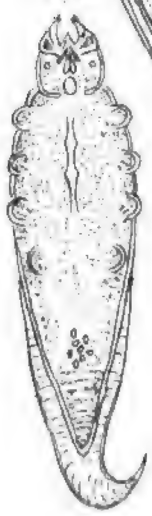


Fig. 6.

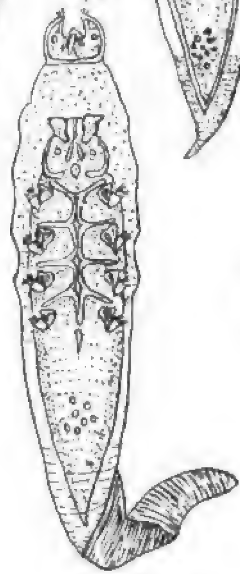


Fig. 9.

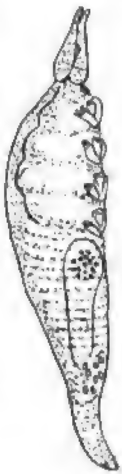


Fig. 10.

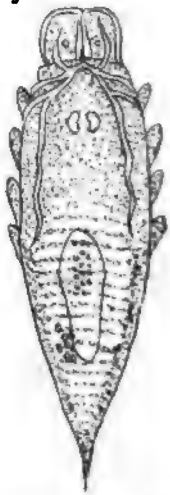


Fig. 11.

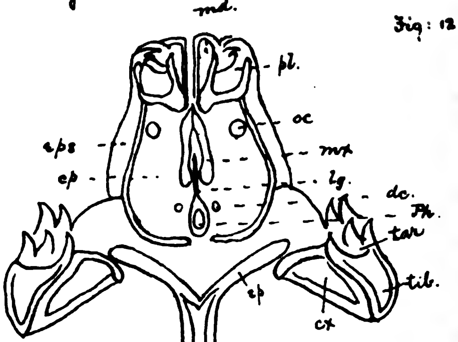
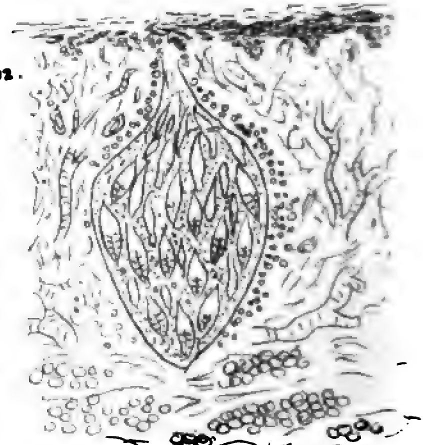


Fig: 12.



After Dr. Osokor
R.R.W.

ON

DEMODEX PHYLLOIDES, *(CSOKOR,)*

IN THE SKIN OF CANADIAN SWINE.

BY R. RAMSAY WRIGHT, M.A., B.Sc.,

Professor in University College, Toronto.

In the *American Naturalist* for December, 1882, I announced the discovery of this Demodex in pieces of pork-skin submitted to me by Mr. R. Awde, Inspector of Food for the City of Toronto. The portion of skin was thickly studded with white tubercles, varying in size from a pin's head to a pea; these did not project much above the surface of the epidermis, but on reflecting the skin the larger ones were seen to extend into the subcutaneous tissue. The tubercles are enlarged sebaceous glands filled with hundreds of mites in various stages of development. The parts of the body chiefly affected are the mouth, cheeks, flanks, belly, and inner surfaces of the legs.

Mr. Awde asserts that one in twenty of the pigs sent in to market in Toronto during the pork season, are affected to a greater or less extent with this cutaneous parasite. In view of such frequency it is somewhat singular that its occurrence has not hitherto[1] been recorded elsewhere, except by Dr. J. Csokor, of the Veterinary Institute at Vienna, Austria, who found in 1879, a herd of swine from Galicia affected in this manner, and described the Demodex causing the disease as a new variety, *D. phylloides*.

The skin in these swine was, however, much more seriously affected, the collections of mites in the glands having caused the formation of subcutaneous abscesses frequently as large as a hazel-nut, which in one or two cases had become confluent on the inner surfaces of the legs. Mr. Awde has never observed any such cutane-

[1] After publishing the note in the *American Naturalist*, I learned that Dr. A. J. Johnson, of this city, to whom Mr. Awde had submitted specimens of affected skin, had sometime ago recognized the parasite as a Demodex, and mentioned the fact of its occurrence at the meeting of the American Microscopical Society, 1881.

ous abscesses. As the parasite is confined to the skin, and does not appear to affect the general health of the animal, he has merely ordered the removal of the skin from the parts involved, a precaution which is entirely sufficient to render the flesh useful for food.

My observations have served to establish the complete agreement of my specimens with those of Csokor. I have accordingly concluded that a synopsis of his paper, which is probably accessible only to a few of those who may be interested in the matter, with a copy of his excellent figures, may stimulate enquiry into the distribution of this parasite in America, and perhaps into the means best adapted to hinder its attacks becoming so formidable as represented by Dr. Csokor.

Dr. Csokor's paper considers:

1. The history of hair-sac mites in general.
2. Their systematic position.
3. The natural history of *D. phylloides* in particular.
4. Its occurrence and mode of life.

1.—Species of Demodex occur in the sebaceous glands and hair follicles beside the nose in man, occasion forms of mange in dogs and cats, and have been recorded (but merely in isolated cases) from the sheep, horse, ox, and Surinam bat. The best known forms have been distinguished by Megnin as three varieties:

D. folliculorum hominis.
D. folliculorum canis.
D. folliculorum cati.

A good many experiments have been made with a view to ascertain whether the Demodex of the dog is capable of being transferred to man, and *vice versa*, and although some results appear to render likely the possibility of both methods of transference taking place, yet the weight of evidence unquestionably points the other way.

The mode of occurrence of the Demodex of the dog is so totally unlike that of the Demodex of man, that apart from difference in form and size, we would be inclined to suspect a difference of at any rate varietal value. In man the Demodex is found on the hairless parts of the face and is perfectly harmless, in the dog it is found in the hairiest parts and brings about a troublesome and often fatal cutaneous disease. Experiments, however, as to transference can hardly be depended upon, for although it is quite certain that the

Demodex may be conveyed from dog to dog, yet experimental attempts to prove this have failed, and very often one dog in a kennel may be affected, and, although mingling freely with the others, may be powerless to infect these.

2.—Systematic Position.

After discussing the results of previous observers as to the anatomy of Demodex, he concludes under his second heading that five well marked varieties may be distinguished, all referable to that genus, viz. :

D. folliculorum hominis.
D. folliculorum canis.
D. folliculorum cati.
D. phyllostomatis (*Leydig*).
D. phylloides (*Csokor*).

The genus he regards with Koch as forming an independent Family of the Acarina the *Dermatophili.*

3.—Natural History of D. Phylloides.

The form of the body and its division into three regions, head, thorax and abdomen (the last distinguished by the absence of appendages and of the chitinous framework present in the thorax), may be studied in Figs. 7 and 8.

The result of a series of comparative measurements shows :

1. That D. phylloides (length, male 0.22 mm., female 0.24—0.26 mm.) reaches the minimum length of D. canis, but never that of D. hominis.
2. Head and thorax are together equal in length to the abdomen, while in D. canis they only form a third of the whole length of the body, and in D. hominis only a fourth.
3. D. phylloides is comparatively almost twice as broad as D. canis or hominis.
4. The head in D. phylloides is absolutely both longer and broader than that of either D. canis or hominis, a circumstance which renders the analysis of the appendages of the head easier in this species.
5. The egg is more oval than spindle-shaped, and both it and the larval stages are longer and broader than the similar stages in D. canis and hominis.
6. There is more difference between D. phylloides on the one hand, and D. canis and hominis on the other, than there is between these two last-mentioned varieties.

THE SKIN.

In the abdominal region the cuticle is transversely striated, an appearance which Csokor attributes to segmentation. In the head the cuticle is not so closely applied to the underlying parts as in the rest of the body—a clear margin resulting, to which Megnin has applied the term epistome. In the thoracic region the cuticle is locally thickened along certain ridges which thus form a chitinous framework. The mesial element of this is the sternum, which gives off laterally four pairs of epimera, and projects also beyond the origin of the last pair of epimera almost as far as the anus. The first pair of epimera run obliquely forwards and form the boundary between the head and thorax. The basal joints of the four pairs of appendages are movably articulated to the outer thirds of the corresponding epimera.

The appendages of the head are three pairs, viz.: 1 pair of mandibles, 1 pair of maxillae, 1 pair of pedipalpi, and an impair stylet-like structure between the maxillae (*lg*, Fig. 11), which, together with these, forms a piercing apparatus, while the mandibles and pedipalpi move chiefly from side to side, and are therefore masticatory. All of these appendages are attached to the cephalic segment. (*cp*, Fig. 11). On the cephalic segment are also to be noticed two punctiform ocelli (*oc*, Fig. 11), and close beside the contour of the pharynx (*ph*, Fig. 11) are two openings (*dc*, Fig. 11) apparently belonging to glands in connection with the pharynx.

The development of the cephalic segment and its appendages is illustrated in Fig. 1–5. First a retraction of the granular contents is noticeable (Fig 1), then a demarcation of the hyaline region as head (Fig. 2), in which an anterior notch containing a pyramidal outgrowth is bounded by two lateral curved processes; these are the future pedipalpi, while the pyramids by a division in the middle line (Fig. 3), and the subsequent longitudinal division of each half gives rise laterally to the mandibles, medially to the maxillae (Fig. 4–5).

The maxillae are curved rods 0.01 mm. in length. (*mx*, Fig. 11). Although chiefly piercing organs, they can also be moved from side to side.

The pedipalpi are three-jointed, the middle joint being soft, while the basal and terminal joints are provided with a chitinous frame-

work. which projects on the terminal joints into three inwardly-directed hooks.

The mandibles are 0.04 mm. in length, and in form resemble a pair of shears with rounded points. (*md*, Fig. 11).

The oesophagus is short, leading directly into the stomach, which occupies the whole of the thoracic cavity, and is possessed of rudimentary caeca answering in position to the appendages, which give the stomach a wavy contour when seen from the side. (Fig. 9). The anus is close behind the sternum.

In accordance with the views of Leydig, the refractive corpuscles, which are to be seen towards the posterior end of the body in the adults as well as in all stages of development, are regarded as urinary concretions.

A rudimentary tracheal system is present, which is represented in Fig. 10. No stigmata have been made out. Between the longitudinal tracheae are two reniform bodies which Csokor is inclined to regard as central organs of circulation.

Csokor studied the locomotion of the Demodex in oil on a hot stage. He found that the movements of the mites became very lively with increased temperature, and is inclined to attribute non-success in experiments as to transference to the absence of a suitable temperature for encouraging locomotion. Pedipalpi, head and legs are all active in locomotion; the head is capable of lateral as well as vertical movement; at a high temperature, also the abdomen may move upon the thorax so as to form an angle with it. The legs are 3-jointed, (Coxa, Tibia and Tarsus; see Fig. 11), but only the two latter take part in locomotion, the tarsus being capable of invagination into the cavity of the tibia. Each tarsus terminates in five equally long claws.

One of the most important of Csokor's results is the establishment of three ecdyses or moults which take place (1) between the egg and the six-footed larva (Fig. 2); (2) between the six and eight-footed larva; and (3) between the latter and the adult.

4.—Occurrence and Mode of Life.

Under this heading Csokor mentions that in the smallest tubercles 50—60 mites may be reckoned, in the larger 500—1,000. The cast-off cuticles are found towards the centre of the tubercle, the younger stages towards the duct of the gland, and the adults

towards the base and periphery of the gland, head downwards. That the mites are air-breathers is apparent from the little bubbles constantly forming under the cover-glass from specimens recently pressed out of a gland.

As the whole of the herd observed by Csokor (22 animals) were attacked by the Demodex, he considers that its transference from pig to pig is evidently more easily effected than is the case with D. canis. The explanation of this is to be sought for in the dirty habits of the pig and uncleanly condition in which they are kept.

EXPLANATION OF THE PLATE.

FIG. 1.—Ripe egg of D. phylloides.

FIG. 2.—First ecdysis: head with rudiments of jaws and ocelli; crenate outline of thorax due to the developing extremities; granules posteriorly may be urinary concretions.

FIG. 3.—First 6-footed larva; appendages of head already well advanced; 6 short feet.

FIG. 4.—Second ecdysis: the jaws in the form of four rods, larval case striped posteriorly.

FIG. 5.—Eight-footed nymph ecdysis beginning posteriorly.

FIG. 6.—Last ecdysis, within the larval skin is the fully developed mite.

FIG. 7.—D. phylloides: male, ventral aspect—the small fissure near the front of the ventral surface of the abdomen is the anus, in front of this two folds represent the penis.

FIG. 8.—Female, ventral aspect—the abdomen contains an egg undergoing segmentation; genital and anal fissure behind the sternum.

FIG. 9.—Female, lateral aspect—the crenate outline towards the dorsal surface of the thorax is the contour of the stomach; the egg inclines towards the genital fissure; the transverse striping of the abdomen is seen to stop abruptly at the thorax.

FIG. 10.—Female, dorsal aspect—the branched tubes are tracheal; the median reniform bodies hearts.

FIG. 11.—Appendages and skeleton of head:

md = mandibles;
mxl = maxillae;
pl = pedipalpi;
oc = ocelli;
lg = ligula;
ph = pharynx;
dc = openings of glands;
st = sternum;
ep = epimera;
cx = coxa;
tib = tibia;
tar = tarsus.

FIG. 12.—Section of skin of pig, with sebaceous gland filled with mites; incipient inflammation.

Figs. 1, 2, 3, 4, 5, 6, were drawn with Hart oc. 2, obj. 8.
Figs. 7, 8, 9, 10 with oc. 2, obj. 7.
Fig. 11, oc. 6, obj. 11.
Fig. 12, oc. 3, obj. 4.

SOME LAWS OF PHONETIC CHANGE IN THE KHITAN LANGUAGES.

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In several published articles, some of which were read before the Canadian Institute, I have given comparative vocabularies illustrating the connection of the American languages with those of the Old World. Among ethnologists there is a strong prejudice against this mode of procedure, a prejudice arising partly from an unwillingness to undertake the labour necessary for an appreciation of the results obtained; partly, it may be, from a suspicion that the vocabulist has been too anxious to prove his point to be scrupulous about the means; and, in particular, from the possibility or probability that the resemblances exhibited are nothing more than such chance coincidences as will appear more or less in comparing any two languages in the world. A similar prejudice might have opposed, and in many minds probably did for a time oppose, the reception of the Indo-European family of languages, for the resemblances presented in their vocabularies as compared among themselves are not a whit more striking than those which characterize a comparison of the languages of north-eastern Asia with those of the principal native races of North and South America. This, however, distinguishes the two linguistic fields; the Indo-European is infinitely better known. Now, speaking of that field, Professor Max Müller tells us that, as far as etymological science is concerned, identity or similarity of sound or meaning is of no importance whatever. This, of course, is true when we are dealing with individual words, but to apply such a rule in the case of a general comparison of vocabularies would be to remove the foundation on which the classification of languages has been laid and from which comparative etymology has sprung. As well go to the extreme at once, and, with Schleicher,

assert that grammatical construction is the only test of linguistic affinity, as if no great changes had taken place in such construction, soul of language though it be, even within the period of modern history. Putting aside such extreme views, or perhaps, as it would be more just to term them, extreme statements, and asking the philologist to suggest some valid criterion of relationship among languages which we deem to be connected and whose grammatical systems are, to say the least, not discordant, he will probably invite us to discover among them such a process of phonetic change as has been illustrated in the case of the Indo-European languages by the well-known Grimm's law. Now it is precisely such a law, or a portion of such a law, that I profess to have found, after a somewhat laborious and careful examination of those New and Old World languages which may constitute provisionally the Khitan family.

The name requires explanation. About the middle of the tenth century, a foreign horde, whom the Chinese annals know as the Khitan, descending from the north, took possession of Mantchuria, and extended their sway over the whole of Northern China. For two centuries they maintained themselves as the rulers of that empire, being recognized in Chinese history as the Liao Dynasty, and were then expelled to the north-east by the Nyuche, a supposed Mantchu tribe, who ruled in their place as the Dynasty of Kin. It was these Khitas or Khitan, for the final *n* is the Khita mark of the plural, who gave to the Celestial Empire its mediæval name Cathay. Some of the Chinese historians derive the Khitan from the desert of Kobi, but, farther to the north about the sources of the Yenisei, and throughout Southern Siberia according to Tartar tradition, their remains are found. These are tumuli, similar to the mounds of this continent, containing arms and ornaments, and sculptured inscriptions upon adjoining rocks in an unknown hieroglyphic character. The Tartars call the tumuli LI KATEI, or the tombs of the Cathayans. Tumuli of the same character as those of Siberia, accompanied in many cases by cup shaped and other rude sculptures agreeing in outline with those found in many parts of this continent, appear in India, where they are regarded as the work of a Turanian people, the Indo-Scyths of history. These must have been none other than the Kathaei of Arrian and Strabo, whom Alexander the Great encountered at Sangala in the Punjaub. The very name Sangala is Khitan, for from the Songari River the Khitan are said to have

descended upon China; to the country of Saghalien they retired; and their presence farther east in Japan is marked by the straits of Sangar. Sangura again or Sagura was the name of a river in the country of the Khita or Hittites, according to the Assyrian inscriptions, and its ethnical character is apparent in its use as the proper name of one of the greatest Hittite monarchs, Sangara of Carchemish. Several native references to the Indian Sangala, as well as that of Isidorus Characenus, make it plain that its population was not Aryan, but Turanian or Indo-Scythic. In the third century, A.D., these Indo-Scyths were expelled or subdued, and at that point the migration northwards through Tartary to Southern Siberia must have commenced. It is natural to suppose, in the want of definite information, that the Kathaei or Khitan reached the Punjaub from the west by skirting the northern boundary of the Persian empire, arriving in their Indian home at or before the fourth century, B.C., when Alexander found them there. The Persian chronicles class among the northern peoples of Touran the Khatai, and link them with Shankul, Prince of Hindustan, another Sagala or Sangala. The original cause of their movement eastward was the capture of the Hittite capital Carchemish on the Euphrates by Sargon, King of Assyria, in 717 B.C., and the consequent dispersion of a brave and restless people unwilling to live under a foreign yoke. Many tribes, as has been shown by Professor Sayce, Dr. Hyde Clarke, and others, found their way into Asia Minor, where Hittite dynasties reigned down into the days of Rome's supremacy. Others, long ages before, when the Kheti invaded the land of the ancient Pharaohs, leaving their Syrian domain, planted colonies in northern Africa, and even penetrated into Europe. But the great bulk of the Hittite population took refuge in the Caucasus, and from thence by dint of pressure, internal and external, forced its eastward way along the route that has been traced in retrograde order, from the Caucasus to the Punjaub, from the Punjaub to the Yenisei, from the Yenisei to the Songari, and thence to Corea, Japan, the Kurile Islands, Kamtchatka, and, finally, as far as the Old World is concerned, to the Aleutian chain. They carried with them their practice of mound building, their peculiar hieroglyphic character, and their own geographical and tribal nomenclature. The mounds begin with the Tells of Syria, are followed on the west by the Lydian and other similar tombs of Asia Minor, on the east by the tumuli of the Caucasus,

India, Tartary, Siberia and Japan, and on this continent give name to their otherwise unknown architects, the Mound Builders. At Carchemish and Hamath, in Phrygia and Lydia, the Hittite hieroglyphics strange and distinctive remain as monuments of Khitan empire and journeyings. The Cypriote syllabic notation has borrowed largely from them; the Libyan and Kelt-Iberian alphabets are their descendants. Some of the more characteristic symbols appear on rudely sculptured rocks in India; the alphabet of Corea preserves many forms identical with those of Hamath; and, in this western world, the few surviving inscriptions of the Mound Builders are unmistakably Hittite, while the Aztec paleography is but an adaptation of the ancient symbolism of Syria to the productions and necessities of a new land. The Hittites of the Hebrew Scriptures are the Kheti of the Egyptian, and the Khita of the Assyrian records, the Ketei of Homer, who left their name to the Keteus river in Mysia, the Kathaei of the Punjaub, the Katei of Siberia, and the Khitan of Chinese history. When, in the 12th century, the Aculhua Tepanecs, traversing the length of the North American continent, arrived in Mexico within the borders of the Chichimec kingdom, they sought to conciliate its monarch Nopaltzin by the tidings that they belonged to the same ancient stock from which he was descended, that namely of the Citin, a race illustrious by its nobility and heroic deeds. Hamath, a Hittite word, yields its meaning only when we discover it in the native name of Japan which is Yama-to, the mountain door; and this again explains the Bible expression, "the entering in of Hamath." Hittite colonists, or Greeks who had dwelt with Hittites in Asia Minor, carried the word into Europe as Haemus and Hymettus. The Kathaei carried it with them to India, where it became on Aryan lips Himavat, afterwards to change to Himalaya. Among the survivals of the ancient name on this continent I may mention Yuma, that of a tribe in south-western California to which, with the other members of the family so designated, I shall have occasion to refer more than once, and Yemez, the name of a Pueblo people of New Mexico. The languages of these two peoples are undoubtedly Khitan. Another group of Khitan names to which I can only briefly refer, as I have already directed attention to them in my paper on "Hittites in America," has been linked with the Kathaei by writers on Indian antiquities. These have supposed that the Kathaei and the Ksha-

triyas are one and the same. The Kshatriyas also were Asuras, and of the Asuras were the Pisachas. With these three names, *Asura*, *Kshatriya*, *Pisacha*, may be compared the Basque *Euskara*, *Haitor*, *Basque* and *Guipuzcoa*, the Caucasian *Iskuria* or *Dioscurias*, the Dioscurian *Castor*, who found his way into classical mythology, *Abasech* and *Schapsuch*, the Khita (of Syria) *Sangara*, *Ashteroth* and *Khupuskia*, the Huron-Iroquois *Tawiscara*, *Ahatsistari* and *Jouskeha* and the Peruvian *Huascar*, *Ayatarco* and *Pasco*, together with the Kheti *Ashtar*, the Dacotah *Seepohskah*, the Muyscan *Bochica*, and many other isolated members of the triad in other tribes and families.

The original physical features of the Khitan must be found on this continent in regions more or less remote from European influences, for in Spain and the Caucasus, in India, and even in Japan, foreign intermixture has so changed the type that little but language and tradition remain to point out a Khitan origin. The measure of Khitan culture was probably never in excess or greatly in excess of that which anciently prevailed in Mexico and Peru. The savage independence of Khitan character appears equally among the tribes of the Caucasus and the Koriaks of Siberia, on the one hand, and among the Dacotahs and Iroquois of this continent, on the other. It is language, however, that determines the relationship of the various members of this once central and historical but now widely scattered family.

Of the African and Indian members of the dispersion, I prefer for the present to say nothing. In Europe the Basques, with their polysynthetic language are the most westerly of the Khitan. In the Caucasus, under modified grammatical forms, the same language survives among the Lesghians, Mizjeji, Circassians, and Georgians. In Central Siberia the Yeniseians are the remnant of the Katei, whose inscriptions are as unintelligible to them as those of the Mound Builders to our Indians. Of the same family are the whole of Dr. Latham's Peninsular Mongolidae, namely, the Koriaks (including the Tchuktchis) of Siberia, the Kamchatdales, the Ainos, Coreans and Japanese, together with the Yukahiri within the Koriak area. The leading American divisions of the Khitan are: in the northern continent the Dacotahs, Huron-Iroquois, Choctaws, Cherokees, Natchez, Adahis, Shoshonese, the Pujunis and Yumas of California, Pueblos Indians of New Mexico and Arizona, the Sonora tribes, the

Aztecs and the Lencas; and in the south, the Muyscas of New Granada, the Quichas, Aymaras, Atacamenos, Sapibocones and Cayubabas of Peru, and the Chileno family, embracing the Chilians, Pampas Indians, Patagonians and Fuegians. The Dacotah, Huron-Iroquois, Choctaw, Shoshonese, Pujuni, Yuma, Pueblos, Sonorá and Lenca divisions comprise many dialects, and, as I propose to treat the Chileno division as one under the name Araucanian, the same will be true concerning it. The dialectic differences of the Basque are few, as are those of the Circassian and Mizjeji, but the Georgian has four dialects, and the Lesghian at least ten. The Yeniseian, Koriak, Kamchatdale, and Aino divisions each present tribal and dialectic differences, and the language of the Loo Choo Islands provides a complement to that of Japan. These dialectic differences are valuable as furnishing the laws of phonetic change within the bounds of a single language, and as aiding in the application of similar laws to forms of speech widely separated geographically.

Instead of setting forth in this paper the whole of my comparative vocabulary of over 150 words in the various languages and dialects of the Khitan family, which would be more likely to confuse than to convince, I prefer for the present to restrict myself to an exhibition of some of the relations of one such language to its connected forms of speech. The language selected is the Huron-Iroquois in its various dialects, the Huron, Tuscarora, Nottoway, Mohawk, Oneida, Onondaga, Cayuga, Seneca, &c. This is one of the most peculiar and difficult members of the family, differing from all the others known to me in this particular, that no one of its dialects possesses the labials *b*, *p*, *v*, *f*, or the liquid and labial *m*. The nearest approach they can make to a labial sound is *w*, and where *m* cannot be similarly represented it must be replaced by another liquid, *n*. With the Huron-Iroquois language I compare first of all that member of the family which, following the line of Khitan migration backwards, is the most remote from it, namely the Basque of northern Spain and south-western France. Grammatically the two languages agree, for it has been rightly said that the Basque is the most American of the Old World tongues known to philology. A better acquaintance than is at present possessed of the languages of north-eastern Asia would doubtless modify such a statement. Still it is well to be on a right footing with the grammarians, although one of them, M. Vinson, a distinguished Basque scholar, who, some time ago, pub-

lished an article comparing the Basque with the Iroquois, failed to find the grammatical accordance of the languages borne out by the lexicon. This, however, arose from the fact that M. Vinson had not made a special study of the Iroquois, and that he had neglected the geographically intermediate languages which, in some respects, furnish the key to the common origin of the Iroquois and the Basque.

I.—IN A LARGE NUMBER OF INSTANCES, ALTHOUGH THERE ARE MANY EXCEPTIONS, THE IROQUOIS REPLACES THE BASQUE LIQUIDS *l* AND *r* BY ANOTHER LIQUID, *n*.

Take, for example, the Iroquois word for tooth, *honozzia*, *onotchia*. It is easy to perceive the relationship between these forms and the *innotay*, *noti*, of the Choctaw, the *ente* of the Natchez, the *noto* of the Shoshonese, and even the *neas*, *nagha*, of the Lenca. But where, it may be asked, is the similarity between these names for tooth and that of the Yuma, which is *aredoche*? The Basque displays the relation. Its word for tooth is *hortz*, *ortz*, or, in the plural, *hortzac*, *ortzac*. The unaspirated *ortz*, somewhat drawn out as is generally the case in the pronunciation of uncivilized man who has abundance of time for his conversation, becomes, without any consonantal change worth noting, the Yuma *aredoche*. If, however, we apply the rule which transforms the Basque *r* into the Iroquois *n*, then *ortz* becomes *ontz*, and *hortz*, the aspirated Labourdin and Bas-Navarrais form of the word, *hontz*, thus furnishing us with abbreviated but distinctly recognizable equivalents of the Iroquois *onotchia* and *honozzia*. In the Kasi Kumuk dialect of the Lesghian the Basque aspirate is strengthened into *k*, *kertshi* being its rendering of *hortz*. Indeed it may almost be said to be a rule that the Basque aspirate, as an initial letter at least, becomes the Lesghian guttural. The Quichua of Peru follows the same rule, and surpasses the Lesghian in its attenuation of the vowel, by changing *kertshi* to *kiru*. Thus the two forms *onotchia* and *kiru*, which appear to present no feature in common, are found to have the same origin.

A similar instance is that of the Iroquois *kelanquaw*, which denotes the moon, but also the sun. The Pueblo word for sun is *hoolenwah*, with which the Yukahiri name for the same orb, *yelonsha*, invites comparison. But in the Basque the equivalent for *kelanquaw*, the moon, is *hilargia*; and, just as the Yuma *aredoche* cor-

responded with the Basque *ortz*, so does the Yuma *hullyar* almost perfectly reproduce the Basque *hilargia*. Let the Iroquois *n* become *r*, and *kelarquaw* is the Basque *hilargia* and the Yuma *hullyar*. The Quichua, still retaining its original guttural, changes *hilargia* and *hullyar* to *coyllor*, but employs the word to designate not the moon but a star. It is worthy of note that the Yukahiri of Siberia, which renders the sun as *yelonsha*, calls the moon *kininsha*, thus replacing the *l* as well as the *r* of *hilargia* by *n*, and preparing the way for the Aino *kunezu* and another Iroquois form, *kanaughquaw*.

An Iroquois word for an axe or hatchet is *ahdokenh*, and this is the Koriak *adaganu*. Turning once more to the Yuma, the phenomenon presented in *aredoche* and *hullyar* is repeated, for the Yuma word for an axe is *atacarte*. Here again we meet with the Basque, for *atacarte* is to *aizkora* as *aredoche* is to *ortz*. In Aino and Japanese the Basque word takes a prefix *m*, and *aizkora* becomes *masakari*.

The Yuma gives us *kooruk* for the adjective old, and the Iroquois, *akaion*; here also the Yuma and the Basque agree, for in the latter language old is *agurea*. But in the Lesghian both forms appear, for, while the Avar and three other dialects accord with the Basque and Yuma in *herau*, two, the Akush and Kubetsh, are in harmony with the Iroquois, *ukna* and *okna* being their respective renderings. In North America the Dacotah also gives two forms, that of the Sioux or Dacotah proper being *kon*, and that of the Upsarokas or Crows, *karrahairea*. The double form *karrahairea* is itself far from singular. The Lesghian tribe of the Avars, besides *herau*, uses *mirvara*, which becomes *noorkoor* in Corean, *porugur* in Aino, and *furuberu* in Japanese.

A remarkable word for egg is the Basque *arraultzia*. The application of the rule to *r* and *l* reduces *arraultzia* to *annauntzia*, which is almost the sound of the Iroquois word *onhonchia*. The Quichua agrees with the Iroquois in changing the *l* to *n*, but retains the *r*, and removes the initial vowel; thus *arraultzia* becomes *runto*. A similar elision of the initial vowel takes place in Kamtschatdale, which furnishes the two forms—*lilchatsh* corresponding with the Basque, and *nyhatch* according with the Iroquois.

In all the Khitan languages there is no radical distinction of adjective and verb. Indeed almost any word may become a verb. Taking the word *dead*, therefore, we find it represented by the

Basque substantive so called, *erio*, *heriotce*, and the Iroquois adjective *kenha*. But *kenha* is the same word as *heriotce*, for, while the Lesghian tribes, Tshar and Kabutsh, render it by *chana* like the Iroquois, the other Lesghian tribes, Dido and Unso, agree with the Basques in calling it *haratz*. The Dacotah sides with the Basque in *karrasha*, and the Peruvian Aymara with the Iroquois in *hinata*.

A road or street in Basque is *kharrika*, but in Iroquois *chanheyens*. The Dacotah, which the late Lewis Morgan proved to be of the same stock as the Iroquois, furnishes the more appropriate form *kanga*, while the Lesghian reconciles the Basque and it by its duplicate renderings *chuldu* and *chuni*. The Corean rejects the termination which appears in *kharrika* and *chuldu* and calls a road *kir*.

The Koriak *ennen*, *innaen*, a fish is the Basque *arran*, *arrain*, and the same with the prefix of a guttural is the Iroquois *kunjoon*. So the Iroquois *enia* a finger is the Basque *erhia*, and the Basque *oscola*, the bark of a tree, is the Iroquois *askoonta*. Again, the Quichua rejects the initial vowel and calls bark *kara*. The *t* of *askoonta* which is not found in *oscola* is probably a euphonic addition merely, since it frequently appears, as in *ourata*, a leaf, the Basque *orri*, in *ashuchta*, a hand, the Basque *escua*, and Dacotah *sake*, and in *kihade*, a river, the Kamtchatdale *kiha*.

II.—The Iroquois replaces the Basque *m* by *an*, *en*, *on*; and the Basque *b* follows the same rule as *m* when it is the equivalent of that letter in the Caucasian languages.

One of the best known Iroquois words is *onontes*, a mountain, figuratively employed to denote a governor or great personage, as *onontio*, the beautiful mountain. This form *onontio* probably explains the Hittite word *mati* in the Hamath inscriptions, which I have translated "king." However, the Iroquois *onontes* is the Basque *mendia*. In South America the Basque form is almost given back in the Araucanian *mahnida*, but the Cayubabas of north-eastern Bolivia, a people allied to the Quichuas, are *Vasconibus Vasconiores* and turn the Iroquois *onontes* into *iruretui*.

The word tongue in Basque is *mia*, *mihia*, the Lesghian *mitz* and *mas*. The application of the rule transforms *mas* to *ennas*, which is just *ennasa*, the Iroquois tongue. The Georgian form is *ena*.

The Caucasian *m* is frequently represented in Basque by *b*. Thus the Lesghian *mussur*, *muzul*, the beard, is the Basque *bizarra*.

There is little doubt that the Lesghian form is the more ancient and radical. In the Atacameno, a Peruvian language of the Quichua family, *musur* survives, not indeed as denoting the beard but the hair. The Iroquois therefore instead of rendering the Basque *b* by *w* recognizes the original in *m* and calls a beard *onwskeru*.

A similar word, *burua*, the head in Basque is the Lesghian *mier*, *maar*, the Corean *mari*, the Dacotah *marshaa*, the Sonora *moola*, the Cayubaba *abara-cama* and *nahuara-cama*. Accordingly in Iroquois its form is not *wara* but *anuwara*.

The radical part of the Iroquois *eniorhene*, to-morrow, is *enior*, and this is the Basque *bihar*, *biar*, *biyar*. While the Iroquois agrees with the Guipuzcoan and Biscayan dialects of the Basque in suppressing the medial aspirate or guttural, it refuses to recognize the initial *b*, and thus claims affinity with the Georgian *michar* and the Corean *myongir*. The Yuma gives back the Georgian form in *mayyokal;* while the Dacotah and Cherokee, preserving the Iroquois form, prefix a sibilant, *shinnakshare* and *sunahla* being their respective terms.

No unscientific collector of verbal coincidences would dream of associating the Basque *bizkhar*, the back, with the Iroquois *ohnaken*. But when we learn that the Basque *bizkhar* is the Lesghian *machol*, it is easily perceived that by the application of the first law *machol* becomes *machen*, and, by that of the second, *machen* is transformed into *onachen*.

III.—WHEN THE BASQUE *b* IS REPRESENTED BY THE SAME LETTER, OR A CORRESPONDING LABIAL IN THE CAUCASIAN LANGUAGES ITS IROQUOIS EQUIVALENT IS *w*.

A Basque adjective meaning great and wide is *zabala*. In Lesghian it appears as *chvallal*, *chvallase*, and similar forms are furnished by the Shoshonese, Aztec, and Atacameno, namely, *oboloo*, *yzachipul* and *capur*. The first rule changes the Basque and Lesghian *l* into the Iroquois *n*, and, by this third rule, the *b* and *v* of these two languages become *w*. Hence we have *kowanea*, the Iroquois word. It is to be remarked that in certain Lesghian and Iroquois dialects the labial disappears altogether, the Lesghian *kunosa* being the counterpart of the Iroquois *hons*.

The Basque word for grass is *belharra*. Here the Caucasian and Basque agree, for *belharra* is the Georgian *balachi*. Accordingly the

Iroquois form is *wennokera*, a term illustrating the first law as well as the third.

The Basque dialects furnish us with two words for hair, *ileac* and *biloac*. In Iroquois also we find *arochia* and *werochia* or *ahwerochia*. The first form corresponds with the Lesghian *ras*, the Aino *ruh*, and the Dacotah *arra*. In the second we meet with the Circassian *abra*. The final *ac* of *ileac* and *biloac* is the Basque mark of the plural, and is the same in origin and in function as the Iroquois *ke*.

Although not entitled to rank as a law of phonetic change, it is worthy of note, as tending to simplify the exhibition of the common origin of Basque and Iroquois, that *the Iroquois frequently differs from the Basque by inserting a dental between the letters n and r, for purposes of euphony.*

Thus the Iroquois *kanadra*, bread, is the Basque *janhari, janari*, food; for the initial *j*, as we learn from M. Lecluse, though pronounced as in French in the canton of Soule, and as in German in that of Labourt, assumes the power of the Spanish letter in Guipuzcoa, and may be represented by *kh*.

The verb to love in Basque is *onerechi, oniritzi*, in which it is easy to recognize the Yukahiri *anoorak*, and the Japanese *noroke*. In Yuma the word is *awvonoorch*. Three Iroquois forms are *endooroohquah*, *aindoorookwa* and *enorongwa*.

A large number of words in Basque and in Iroquois coincide in sound and in signification, and for such coincidence I have so far been able to discover no law. Among these may be mentioned the Iroquois *garioha*, bird, which is the Basque *choria*, the Lesghian *zur*, the Aymara *chiroti*. The final *ti* of the Aymara has also appeared in *hinata*, dead, as compared with the Iroquois *kenha* and the Lesghian *chana*. The Iroquois white, which English missionaries write *kearugea* and the French *kenraken*, is the Basque *churia*, the Japanese *kiroi*, the Loo Choo *shirusa*, the Lesghian *tchalasa*, and the Quichua *yurac*. An Iroquois word for dog is *tschierha*, the Shoshonese *schari*, the Mizjeji (Caucasian) *tkari*, the Georgian *djogori*, and the Basque *zacurra*. So the Basque *hezurra*, bone, is the Iroquois *ohskereh*, and the Cherokee *ookolah*; and the Basque *aztala*, leg, is the Iroquois *okotara*, and the Lesghian *uttur*. While *geree*, an Iroquois word for tree, agrees with the Basque *chara* and the Quichua *kullu*, meaning wood, another Iroquois form, *kaeet*, is the Lesghian *hueta*, *guet*, the Basque *zuaitz*, *zuhaitz*, and the Aztec

quahuit, quauitl. The Khitan terms for thunder are like the Semitic *gilyad.* The Lesghian seems to furnish the type in *gurgur*, which is approached by the Basque *curciria, ihurzuria*, and aggravated in the Koriak *urgirgerkin.* The Georgian modifies the harsh sound by dropping one of the *r*'s, as in *gurgin* and *kuchili*, the latter of which corresponds with other Koriak forms, *kyhal, kyigala*, and with the Kamtchatdale *Kychichlizen.* The Choctaw has the two forms *jyrajaa* and *hiloha;* the Yuma stops short at *aker;* but the Iroquois furnishes a word *kawseras* that agrees more perfectly with the Old World forms.

I have already referred to the Yuma dialects (the Yuma or Cuchan, Maricopa, Mojeve, Dieguno), as valuable members of the Khitan family for comparative purposes. Two Yuma words for cold are *xetchur* and *hutseelo.* The former accords with the Dacotah *hootsheere* and the Iroquois *otsorai*, which the Basque changes to *otsbero*, while in *hutseelo* we find the Lesghian *chuatzala.* The connection of the Iroquois *onyare*, neck, with the Basque *cinzurra* might seem doubtful, as the Basque sibilant and guttural prefixes are generally more conspicuous by their absence than by their presence. But the Yuma form *henneeil* shows that it is the Iroquois which errs by default in this respect. The Yukahiri *jomuel* restores that original form which would naturally have been looked for in the Basque, and leads the way to the Lenca *ampshala.* The Lesghian word *gabur*, which could never be evolved out of *cinzurra*, naturally rises out of *jomuel.*

The Iroquois *onuste*, maize, and the Basque *arto, artho*, have little in common. The Yuma *tarrichte*, however, dropping the initial *t* and applying the first rule as if it were a Basque word, becomes *annichte.* Another Yuma form is *terditch*, with which may be compared the Lesghian *zoroto* and the Circassian *nartuch*, and with these the relation of the Basque *arto, artho* is easily perceived.

Still another Yuma word meaning to speak is *atchahquerck.* This is undeniably the Aino *itakguru.* But another Aino dialect gives *idakuwa*, and this prepares us for the Iroquois *atakia* and the Basque *itzegin.* The nearest word to the Yuma *haweel*, meaning a river, is the Aymara *hahuiri* or *hawiri*, and this is plainly the Lesghian *uor, chyare*, and the Basque *uharre, uharka.* In *chyare*, by the application of the first rule, we detect the Iroquois *kahionha.*

In some cases the Basque word, while agreeing with the Iroquois, differs from the Lesghian, so that both Iroquois and Basque must be brought under the first rule, in which Lesghian must take the place of Basque. Thus the word for name is in Iroquois *chinna* and in Basque *icena*, while the Lesghian form is *zar*.

Certain roots also which I have not found in Basque unite the Lesghian and the Iroquois. Such is the Lesghian *surdo*, night, which is the Iroquois *asunto*. Another Lesghian form *chur* agrees with the Aino *asiru*. The Lesghian *ras*, a feather, is the Iroquois *onasa*. The Iroquois word for rain, *iokennores*, is not very like the Lesghian Kasi-Kumuk form *kural*, but is at once recognisable in that of the Akush dialect, which is *kanili*. In fact the phonetic changes which I have pointed out as existing between the Basque and the Iroquois are really found operating in greater or less measure within the bounds of individual Khitan languages both in the Old World and on this continent. Even the Kamtchatdale, which generally accords with the Iroquois, gives occasionally a Basque form, as in *kchailta*, the belly, as compared with the Iroquois *kchonta*.

Before concluding the list of examples, which, however tiresome to enumerate, I feel are due from me to those who would themselves judge the validity of the laws which I have enunciated, I wish to set forth the relations of two connected Iroquois words the derivation of which has long been sought in vain. The first is the word for house *onushag*, *kanuchsa*, *anonchia*, *kanonsa*. Beginning near home, the Shoshonese *niki* and Sonora *nihki* should not be foreign to the Iroquois forms, especially as another Shoshonese form *kanuke* almost reproduces the Iroquois *kanuchsa*, and as the Sonora *kaliki* is the same word. The Shoshonese has still another form *liki*, which is the Araucanian *ruka*, and the Lesghian *ruk*. If, however, we ask how the Iroquois forms *anonchia* and *kanonsa* obtained their double *n*, we must be referred to the Koriak, which renders the Lesghian *ruk* by *oranga*, and this the Iroquois changes to *onanga*, *anonchia*. The Aztec *calli*, different as it may appear, is the same word, for the Sonora which gave us *kaliki* abbreviates this in certain dialects into *kari*, from which *calli* is derived by the simplest of all phonetic changes. The other word is that which gives name to our Dominion, *kanada*, *kanata*, a village. Nobody would dream of associating it with the Natchez word *walt*, and yet their derivation is one. The language of the Yenisei furnishes the original term, *kelet*, *koleda*,

unless we are disposed to admit the prior claims of the Circassian *sheekday* or the Georgian *kalaki*.

Nothing can prove more convincingly the wonderful vitality of words even among peoples devoid of literature than the comparison just instituted between the Basque and the Iroquois. If it be allowed that the separation of the two stocks only took place at the time when the Hittite empire was overthrown by the Assyrian Sargon, for certainly it can be placed at no later period, then it follows that 2,600 years have passed since the ancestors of the Vascones and those of our Hurons and Iroquois mingled their voices on the banks of the Euphrates. But if, as is far more probable, the Basques reached their Spanish home by way of Northern Africa, this journey must have been undertaken long centuries before, when that Shepherd tide of conquest, in which the Kheti formed a mighty wave, was driven back upon the desert sands and the Mediterranean shore by the great Egyptian Pharaohs of the 18th dynasty. When Moses was still a child, and the ancient Hebrew language had not yet assumed a literary form, the Khitan wanderers carried their imperishable speech across the Libyan sands to plant it at last in the remotest bound of the European continent.

Even now we hear much of the Atlantis theory, of the population of America from Western Europe and Africa by means of a submerged continent, or by such brave sea daring as brought Columbus to the New World, and the very connection of the Basque and Iroquois languages tempts the question : May there not be truth in such a theory ? But language, which has established the relationship of the peoples, refutes the theory. Our Huron-Iroquois came not to the east first but to the west, not to the south but to the north. Their features, their religion, their character and customs are distinctively Koriak, and their appearance upon the stage of American history began at a time when, had Biscay or Morocco been their starting point, they must have brought with them some traces at least of mediæval culture. Euskara and Basque, names of a people only in Spain, are to the Iroquois Tawiscara and Jouskeha, gods or divine ancestors of the race, whose memory has vanished long years ago from Guipuzcoa and Navarre. The Basque is a seaman, but some other race than his own, that of his mother, it may be, who gave the European tint to his dusky complexion, must have taught him to hold the sail and brave the dangers of the ocean, for the

Khitan, fierce, warlike, indomitable, as many of their tribes have proved themselves on mountain and plain, have never taken rank among the masters of the sea. Their very passage to this Western World has been the stepping stones of the Kurile and Aleutian Isles, with land in sight for almost all the way.

To return to language; we look in vain in our Basque lexicons for the compound words of the Iroquois tongue, but in Koriak, in Kamtchatdale, and in Japanese, we discover, not indeed the precise words, for a few centuries may suffice to alter these, but some of the elements of which they are composed. Take, for instance, the Iroquois word for silver. It is *hwichtan-oron*. I am not sufficiently versed in ancient Iroquois to know the meaning of its component parts, but there can be no doubt that the first of these, *hwichtan*, is the same as *wychtin* in the Koriak word *elnipel-wychtin*, denoting the same metal. An Iroquois word for the colour yellow is *cheena-guarle*, and *guarle* is apparently the same word as *karallo* in the Kamtchatdale *duchl-karallo*, which means not yellow indeed but green, colours not always distinguishable by savages, for the Koriak uses the same term, *nijil-tshachain*, for both. Another Iroquois word for yellow is *hotgikkwa-rogon*, of which the latter member, *rogon*, corresponds with *grachen* in the distinctive Koriak term for yellow, *nuutel-grachen*. We are on a surer foundation in regard to the Iroquois words for red, two of which are *otquech taroku* and *quwen-tarogon*. The first part of each word is a variation of the terms *otweacha*, *hotkwensa*, blood. The Koriak red is *nitshel-rachen*, although *nitshel* is sometimes used alone. The latter Koriak word does not seem to denote blood. Still the *rachen* of *nitshel-rachen*, red, and the *grachen* of *nuntel-grachen*, yellow, are doubtless variations of the Iroquois *rogon* of *hotgikkwa-rogon*, yellow, and the *tarogon* of *quwen-tarogon*, red. The explanation of these terms is found in the Japanese. One of its words for red is *chi-darake-no*, literally, "smeared with blood," for *chi* denotes "blood," and *darake*, or with the particle *darake-no*, means "smeared with." Hence the Iroquois words for red, in which we have already found the equivalents of the Japanese *chi*, blood, plainly exhibit their Northern Asiatic origin, for *taroku* and *tarogon* are the Japanese *darake* and *darakeno*, as well as the *rachen* and *grachen* of the Koriak. Taking the Japanese also as the more correct form of the language, it follows that the Iroquois have been

more careful of their speech than the Koriaks. The Atlantis theory gains no support from philology.

If in this paper I have not exhibited the relation of the Iroquois dialects to those of all the divisions of the Khitan family, it is not from lack of material or in order to avoid any difficulty. I have purposely chosen for comparison languages the most remote in place and in time of separation from the original tongue, languages of peoples most unlike in present feature and character, whose sole connecting link has been supposed to be the common possession of a complicated grammatical system marked by polysynthesis. That I have succeeded in showing the relation of these languages to one another and at least to some of the intermediate members of the Khitan family, will be granted, I doubt not, by all true philologists who do not shut their eyes at antecedent improbability.

RULE I.

THE IROQUOIS REPLACES THE BASQUE *l* AND *r* BY *n*.

	BASQUE.	RULE APPLIED.	IROQUOIS.	ENGLISH.
1.	ortz, hortz	ontz, hontz	onotchia, honozzia	tooth
2.	hilargia	hilangia	kelanquaw	moon
3.	aizkora	aizkona	ahdokenh	axe
4.	agurea	agunea	akaion	old
5.	arrautzia	annauntzia	onhonchia	egg
6.	herio	henio	kenha	dead
7.	kharrika	khannika	chanheyens (*Dacotah*, canga)	road
8.	arrain	annain	kunjoon	fish
9.	erhia	enhia	enia	finger
10.	oscola	oscona	askoonta	bark

Note.—ILLUSTRATIONS OF THE RULE IN OTHER LANGUAGES.

BASQUE FORMS.	IROQUOIS FORMS.
1. ortz = rytti, *Koriak;* aredoche, *Yuma* hortz = kertshi, *Lesghian;* kiru, *Quichua*	onotchia = innotay, noti, *Choctaw;* ente, int, *Natchez;* noto, *Shoshonese;* neas, nigh, nagha, *Lenca*
2. hilargia = hullyar, *Yuma*; coyllor, *Quichua*	kelanquaw = gailgen, *Koriak;* yelonsha, *Yukahiri*; hoolenwah, *Pueblos.*
3. aizkora = masakari, *Japanese, Aino*; atacarte, *Yuma*	ahdokenh = adaganu, *Koriak*; tlateconi, *Aztec.*
4. agurea = herau, *Lesghian*; kooruk, *Yuma*; karrahairea, *Dacotah*	akaion = ukna, okna, *Lesghian*; kon, *Dacotah*
5. arrautzia = lilchatsh, *Kamtchatdale*; runto, *Quichua*	onhonchia, = nyhatch, *Kamtchatdale*; nanki, *Shoshonese*
6. herio, heriotce, = haratz, *Lesghian*; carrasha, *Dacotah*	kenha = chana, *Lesghian*; hinata, *Aymara*
7. kharrika = shara, *Georgian*: chuldu, *Lesghian*; kir, *Corean*	chanheyens = chuni, huni, *Lesghian*; canga, *Dacotah*; hinah, *Choctaw*
8. arrain atlan, *Aztec*	kunjoon = ennen, innaen, *Koriak*; henn, *Natchez*; kanu, *Aymara*
9 erhia = kilish, *Lesghian*; gelyhat, *Koriak*; hal, *Yenisei*	enia = onkahah, *Dacotah*
10. oscola = kerki, *Georgian*; ichalgyu, *Koriak*; kara, *Quichua*	askoonta = kani, *Georgian* (skin); cangha, chanha, *Dacotah*

RULE II.

THE IROQUOIS REPLACES THE BASQUE *m* BY *an*, *en*, *on*, AND THE BASQUE *b* BY THE SAME WHEN *b* IS THE EQUIVALENT OF THE CAUCASIAN *m*.

BASQUE.	CAUCASIAN.	IROQUOIS.	ENGLISH.
1. mendi	mta, *Georgian* suntu, *Lesghian*	onontes	mountain
2. mia, mihia	mitz, mas, *Lesghian* ena, *Georgian*	ennasa	tongue
3. bizarra	mussur, muzul, *Lesghian*	onwskera	beard
4. burua	mier, maar, *Lesghian*	onuwara	head
5. biar, bihar, bigar	michar, *Georgian*	enior-hene	to-morrow
6. bizkhar	machol, *Lesghian*	ohnaken	back

Note.—ILLUSTRATIONS OF THE RULE IN OTHER LANGUAGES.

BASQUE AND CAUCASIAN FORMS.	IROQUOIS FORMS.
1. mendia = mahnida, *Araucanian*; pinujidtsh, *Kamtchatdale*	onontes = suntu, *Lesghian*; neit, *Koriak* nenichaba, *Choctaw*
2. mia, mas = mutt, motte, *Mizjeji*	ennasa = ena, *Georgian*; onnor, *Yukahiri*; neeighjee, *Dacotah*; yahnohgnh, *Cherokee*; honinee, *Pueblos*; anongin, *Shoshonese*; nenetl, *Aztec*; ine, *Cayubaba*
3. bizarra, mussur = musur, *Atacameno*; muzul, (hair)	onwskera = hannockqueli, *Shoshonese* (chin); huntur, *Atacameno*
4. burua, mier, maar = mari, *Corean*; marshaa, *Dacotah*; moola, *Sonora*; abara-cama, *Cayubaba*	anuwara = nahuar-acama, *Cayubaba*
5. biar, michar = myongir, *Corean*; mayyokal, *Yuma*; miecar, *Yuma* (morning); emukulas, *Kamtchatdale* (morning)	enior-hene = unhalel, *Yukahiri* (morning); onnihile, *Choctaw* (morning); sunahla, *Cherokee* (to-morrow and morning); shinnakshare, *Dacotah* (to-morrow and morning); yanrne, *Shoshonese* (morning)
6. bizkhar, machol = ushiro, *Japanese*	ohnaken = senaka, *Japanese*

RULE III.

THE IROQUOIS REPLACES THE BASQUE *b* BY *w* WHEN *b* IS THE EQUIVALENT OF A LABIAL IN THE CAUCASIAN LANGUAGES.

BASQUE.	CAUCASIAN.	IROQUOIS.	ENGLISH.
1. zabala	chvallal, chvallase, *Lesghian*	kowanea	great
2. belharra	balachi, *Georgian*	wennokera	grass
3. biloaç	abra, *Circassian*	ahwerochia	hair

RULE IV.

THE IROQUOIS INSERTS A DENTAL BETWEEN THE BASQUE *n* AND *r*.

BASQUE.	IROQUOIS.	OTHER LANGUAGES.	ENGLISH.
1. janari, janhari	kanadra	kendowan, *Koriak*	bread, food
2. onerechi, oniritzi	endoorohquah aindoorookwa	anurak, *Yukahiri* noroke, *Japanese* awvonoorch, *Yuma*	to love

ROOTS COINCIDING IN BASQUE AND IROQUOIS.

BASQUE.	IROQUOIS.	OTHER LANGUAGES.	ENGLISH.
1. choria	garioha	zur, *Lesghian*; chiroti, *Aymara*	bird
2. churia	kearagea	kiroi, *Japanese*; shirusa, *Loo Choo* tchalasa, *Lesghian*; yurac, *Quichua*	white
3. zacurra	tschierha	djogori, *Georgian*; tkari, *Mizjeji* schari, *Shoshonese*	dog
4. hezurra	ohskereh	ookolah, *Cherokee*	bone
5. aztala	okotara	uttur, *Lesghian*	leg
6. chara zuaitz, zuhaitz	geree kaeet	kullu, *Quichua* hueta, guet, *Lesghian* quahuit, quauitl, *Aztec*	wood, tree
7. curciria	kawseras	gurgur, *Lesghian* urgirgerkin, kyhal, kyigala, *Koriak* kychichlizen, *Kamtchatdale* gurgin, kuchili, *Georgian* jyrajaa, hiloha, *Choctaw*; aker, *Yuma*	thunder

The Yuma dialects as aids to comparison.

Iroquois.	Yuma.	Basque.	Other Languages.	English.
1. otsorai	xetchur hutseelo	otsbero	chuatzala, *Lesghian*	cold
2. onyare	henneeil	cinzurra	jomuel, *Yukahiri* ampehala, *Lenca* gabur, *Lesghian*	neck, throat
3. onuste	tarrichte terditch	arto, artho	zoroto, *Lesghian* nartuch, *Circassian*	maize
4. atakia	atchahquerck	itzegin	itakguru, idakuwa, *Aino*	to speak
5. kahionha	haweel	uharre	uor, chyare, *Lesghian* hahuiri, *Aymara*	river

(*See also under Illustrations of Rule I.*)

Miscellaneous Examples of Affinity.

Iroquois.	Caucasian.	Other Languages.	English.
1. chinna	zar, *Lesghian*	icena, *Basque*	name
2. asunto	surdo, chur, *Lesghian*	asiru, *Aino*	night
3. onasa	ras, *Lesghian* kamesh, *Misjeji*	hanni, *Loo Choo*	feather (wing)
4. iokennores	kanili, kural, *Lesghian*	chenar, *Shoshonese*	rain (hail)
5. kehonta	siarad, *Lesghian*	kchailta, *Kamtchatdale* xillantli, *Aztec*	belly
6. onushag, kanonsa	ruk, *Lesghian*	ruka, *Auracanian* kanuke, liki, niki, *Shoshonese* kaliki, cari, nihki, *Sonora* calli, *Aztec*; oranga, *Koriak*	house
7. kanada, kanata	sheelday, *Circassian* kalaki, *Georgian*	kelet, koleda, *Yenisei* walt, *Natchez*	village

The relation of compound words in Iroquois.

Iroquois.	Japanese-Koriak.	English.
1. hwichtan-*oron*	*elnipel*-wychtin, *Koriak*	silver
2. *cheeua*-guarle	*duchl*-karallo, *Kamtchatdale*	yellow
3. *hotgikkwa*-rogon	*nuutel*-grachen, *Koriak*	yellow
4. *otquech*-taroku *quwen*-tarogon	*nitshel*-rachen, *Koriak*. *chi*-darake, *chi*-darakeno, *Japanese*	red

NOTES ON
SOME CANADIAN INFUSORIA.

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For some weeks past I have been occupied in identifying some Infusoria found in water from a pool in the neighbourhood of the Ontario Agricultural College, Guelph. This was obtained during the past summer, and has been standing in a moderately warm spot since. Even during the time I have been engaged in investigating it, its fauna has varied considerably, depending, to a certain extent at least, on the temperature, which has been allowed to vacillate within somewhat wide limits. A lowering of temperature will no doubt cause the disappearance of certain forms, whereby other more hardy ones, in the struggle for existence, will, by obtaining more abundant food be able to propagate themselves, and hence appear more abundantly, and also no doubt it will act indirectly upon certain other forms by destroying their usual food, and thus eventually causing these forms to disappear also, although they may of themselves be able to withstand the increased cold.

The only reference I have been able to find to any researches on the influence of low temperature on Infusoria is contained in Semper's work on the Natural Conditions of Existence as they affect Animal Life. He there alludes to Rossbach's investigations as to the influence of temperature on the pulsation of the contractile vesicle, which show that at 5° c. the contractions follow each other at long intervals, and at 3° c. a condition supervenes, which Rossbach has termed "chillcoma," from which the animal can be roused by increasing the temperature, but if it be long continued at that degree, death supervenes. These observations were conducted only with *Chilodon cucullus*, *Euplotes charon* and *Stylonychia pustulata*, and even in these forms considerable variation was observed.

Many data, however, are yet required to elucidate the action of external conditions on these low forms, and my professional duties have not allowed of a sufficient inquiry into the subject to permit of any generalizations or instances being given here.

In the following notes I do not pretend to give a complete list of all the forms observed, but shall merely deal with certain forms which seem to merit description. In the first place, however, it will be well to record the general zoological and botanical characters of the water.

As to the vegetable life observed, there was in the first place always a large quantity of a small species of *Nostoc*, apparently *N. lichenoides*, var. *vesicarium*, usually mucous or hollow in the interior, the threads traversing the cavity being surrounded each with its own gelatinous envelope. *Oscillatoriæ*, *Spirogyra*, *Protococcus* and various forms of *Chroococcaceæ* were also present in considerable abundance, although towards the last the *Spirogyra* threads disappeared. Diatoms—principally *Navicula* sp.? and Desmids belonging to the genera *Cosmarium*, *Closterium*, *Scenedesmus* and *Ankistrodesmus* were exceedingly numerous, and like the *Nostoc* were apparently not at all affected by cold. Latterly many *Bacteria*, *Bacilli* and *Spirilla* were present, and in regard to the latter I noticed, that when only a small portion of the slide was kept illuminated for a length of time, by the use of a diaphragm with a small aperture, they invariably congregated in large numbers at that spot, apparently showing that these low forms have appreciation of light. Engelmann, however, shows [1] that these forms only approach the light for the purpose of obtaining oxygen, which, under its influence, is given off from green algae, etc., only two bacterial forms being observed by him, which are attracted to the light for the light's sake—*Bacterium chlorinum*, which is of a green colour, and *B. photometricum*, slightly reddish in colour.

As to the animal life, in addition to Infusoria, many lower and higher forms were present. When first procured the water contained numbers of specimens of *Daphnia pulex*, De Geer, in company with which were an undetermined *Ostracode*, and *Cyclops quadricornis*. Of these the two former soon disappeared completely, the *Cyclops* disappearing when the water was exposed to a moderately low tem-

[1] Revue Internat. Sci. Biol. ix., 1882. Cf. Journ. Roy. Micr. Soc. ii., 1882.

perature, reappearing when the temperature increased, the ova apparently not being affected at a temperature which destroys the adult animal. This is a well-known phenomenon, and is exemplified by many of our Insects, which perish in the Fall, but whose eggs are able to withstand the intense cold of Winter. These same remarks apply to the Rotifer *Philodina citrina*, which was also present in considerable numbers. A single Nematode worm, which I did not identify, and several examples of a Planarian were seen, the latter possessing a distinctly vacuolar parenchyma. Of the lower forms of life many examples were observed: *Arcellæ*, especially *A. dentata*, *Amœbæ*, *Actinophrys sol*, and many *Flagellata*. Of these the *Arcellæ* persisted through all the changes, the *Amœbæ* perished in low temperatures, and *Actinophrys*, having only appeared lately, has not been exposed to cold.

With these preliminaries I shall now pass on to my observations on certain Infusoria, which I regret are somewhat incomplete, owing both to lack of sufficient time to perfect them, and more especially to the want of the necessary literature, which, for efficient work, shoud be continually at hand.

Metopus, *nov. spec.*

The genus *Metopus* was originated by Claparède and Lachmann for the reception of a species formerly described by O. F. Müller as *Trichoda sigmoides*, and by Perty as an unknown form. It presents many peculiarities, and has hitherto been frequently mistaken for other forms; Balbiani, for instance, mistaking it for the young form of *Spirostomum ambiguum*. It has been described from several localities in Europe, Claparède and Lachmann having found it at Berlin, Englemann at Leipzig, Stein at Tharand and Niegmegk (very numerous among *Lemna polyorrhiza* and *trisulca)*, and Balbiani at Paris, but as far as I can ascertain it has not yet been described from America.

The characters of the genus are thus given by Kent[1]: "Free-swimming, highly elastic and changeable in shape, normally elongate, oval, or fusiform, rounded at both extremities, cylindrical or only slightly flattened; the anterior portion usually twisted obliquely towards, and overlapping the left side of the ventral surface, sharply

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[1] Manual of the Infusoria. London. 1882.

separated from the posterior portion; peristome field furrow-like, commencing on left side a little distance from the anterior extremity, produced obliquely downwards towards the right in a groove formed by the oblique curvature of the body, and terminating in a short pharynx at or shortly past the middle line; on the contraction or shortening of the body, the peristome with the pharynx for the time describes a complete spiral circuit, the animalcule presenting in this condition a totally different aspect; anal aperture postero-terminal; contractile vesicle single, posteriorly located. Inhabiting salt and fresh water."

With this definition of the genus my observations, although identical in most particulars, do not exactly correspond. The points on which I differ are mainly the position of the anal aperture, and the number of contractile vesicles. On reference to the figure (Pl. fig. 1), it will be seen that I have represented the anus (a) as being *postero-lateral*, and I have done so only after having witnessed the emission of unconsumed food from that point. Claparède and Lachmann[1] did not observe the anus, but merely suppose it to be situated posteriorly. Stein,[2] however, distinctly states that it is postero-terminal, and on his authority it is so described above. As to the contractile vesicles, I have observed two, one situated in front of the pharynx (*a. c. v.*) and the other (*p. c. v.*) near the posterior extremity but not quite central. On first observing the form I did not see the anterior vesicle, probably on account of the constant rotation about their long axis which the animals performed, and which, as the vesicle is situated slightly in front of the junction of the overlapping anterior portion with the posterior one, would render it liable to be overlooked. I, however, lately observed it in one form, but having lost it, and having not as yet discovered another, I am unable to confirm the observation. I would then alter these points of the generic definition so as to read, "anal aperture posterior; contractile vesicle single or double."

The only species belonging to this genus that I have been able to find reference to is *M. sigmoides*, and for it the genus was formed. The descriptions of this form vary somewhat, but in no particular sufficiently important to establish a new species. The characters of

[1] Etudes sur les Infusoires et Rhizopodes. 1858–1860.

[2] Der Organismus der Infusionthiere.

the form which I observed differ so very considerably from those of *M. sigmoides*, that I think it necessary to regard it, however, as a new species. *M. sigmoides* is described by Claparède and Lachmann as having the buccal fossa bounded by cilia much more vigorous than those of the rest of the body. In the digestive cavity anteriorly are constantly found a number of granules, highly refractive, whose signification is still problematic, and which recall very strongly those found frequently in *Paramecium Aurelia*, and in certain *Nassulæ*. The contractile vesicle is spacious, and lodged in the posterior half of the body, which is S-shaped. In the figure they represent the nucleus as a morula-like structure. Engelmann[1] describes it thus: "It reaches a size of only 0.15 mm., posteriorly is bent towards the right not quite S-shaped, possesses at the posterior extremity some long bristles and at the centre of the body a usually curved reniform nucleus. *Metopus* possesses an adoral row of cilia of short bristles, which are however in a strange manner fastened not on the upper but on the lower side of the long peristome field. The upper border of the peristome bears the usual cilia, as well as the whole anterior half of the body." Engelmann's form accordingly differs from that of Claparède and Lachmann in the possession of terminal setæ, which are neither mentioned by the latter authors in the text, nor represented in their figure; also in the absence of the highly refractive bodies, and in the shape and appearance of the nucleus. Stein, again, describes this same form as occurring in three distinct shapes—the normal, described above, the shortened, and the rolled up; and also describes a bunch of terminal setæ and a terminal anus. He criticises Claparède and Lachmann's figure somewhat harshly, pointing out the non-pourtrayal of the proper curvature of the posterior portion of the body, and the incorrectness of the structure of the peristome and the nucleus, and the absence of the terminal bristles. He evidently does not recognize the possibility of the form observed by the Swiss authors being different from that he describes.

The form I observed differs from these descriptions in many respects, and the various differences may be discussed serially.

(1) The twisting does not appear to be as extensive as described for *M. sigmoides*. On examining the figures of C. and L. it appears that the plane of the anterior half of the body is parallel with that

[1] Zeit. für Wiss. Zool. XI. 1861.

of the posterior half; whereas in my form they are almost at right angles, and are more like Engelmann's description, "not quite S-shaped."

(2) The situation of the anal aperture.

(3) The presence of two contractile vesicles.

(4) The presence of terminal setae distinguish it from C. and L's form, but in this particular it resembles those of Engelmann and Stein.

(5) The granules of the external portion of the protoplasm are arranged in rows so as to give the borders of the body a striated appearance, one stria apparently corresponding with each cilium. This appearance is particularly noticeable, and is not represented in any of the descriptions above referred to, and it may certainly be concluded that it was not present.

(6) The nucleus (n) is situated near the pharynx, and is ovoidal, with an endoplastule. In this it resembles Stein, but differs from the other observers.

(7) The peristome field does not bend round the body as represented by Stein and C. and L., but merely runs obliquely downward, being expanded at the top. This is dependent on the lesser extent of the twisting in my form.

As regards the size of my form, it ranges from 0.17–0.19 mm., while Engelmann's measured 0.15 mm., and, according to Kent, Stein's (?) measures $\frac{1}{300}$ $\frac{1}{80}$ of an inch, equivalent to 0.08–0.3 mm., a sufficiently large range to include almost anything, but which may be explained by the existence, according to Stein, of three distinct forms. Of the pharyngeal cilia, I can say nothing, not having sufficiently studied them.

Taking into consideration these various points, I think the form under observation was sufficiently characterized to be denoted a new species, but so much variation occurs in the descriptions of *M. sigmoides*, as given by different observers, that I do not feel justified in giving my form a name, until by renewed research I have fully satisfied myself of its specific distinctness.

SCYPHIDIA INCLINANS, D'UDK.

The genus *Scyphidia* belongs to the solitary, sessile *Vorticellidæ*, and attaches itself to foreign objects by means of an acetabuliform organ. Considerable doubt prevails as to the true position of many

forms described as belonging to the genus. It was originated by Dujardin for the reception of *S. rugosa*, and Perty described another form as *S. patula*. Lachmann,[1] however, disputes both these identifications, regarding the forms as being merely recently attached immature *Vorticellæ*, and admits to the genus only two forms discovered by himself, viz.: *S. limacina* attached to small *Planorbis*, and *S. physarum* attached to *Physa fontinalis*. Kent, in his Manual of Infusoria, refers two other forms to this genus. Fromentel described a form as *S. rugosa*, from which, however, it differed in possessing three contractile vesicles, and a very short footstalk; this Kent terms *S. Fromentelli*. D' Udekem's *Gerda inclinans* he also places in this genus, the discoverer being somewhat undecided where it belonged, having described it as belonging to the closely allied genus *Gerda*, while expressing a doubt whether it might not be referred to Dujardin's *Scyphidia*, or to an immature form of his own *Epistylis tubificis*. The form I had under observation (Pl. Fig. 2.) presented a very close resemblance to this, differing, however, in some points from Kent's description. Unfortunately, I only met with a single example. This measured 0.075 mm., and was over three times as long as broad. The adherent disc I was unable to see, as the extremity of the foot was constantly concealed among confervæ. It tapers considerably posteriorly, and the body presents a fine transverse striation. The ciliary disc is elevated somewhat above the peristome, is inserted somewhat obliquely, and is capable of retraction. The mouth occupies the other half of the peristome, which is furnished with a few bristle-like cilia. The ciliated pharynx leads down from the mouth towards the centre of the body. Immediately beneath the edge of the peristome and below the ciliary disc is the single contractile vesicle (*c. v.*), while below it was a granular ovoid body (*n.*), corresponding with which was a similar structure on the other side of the pharynx. I was not able to distinguish any connection between these two bodies, but imagine them to be portions of the nucleus. According to Kent's description, D' Udekem's form differs from mine in the comparative length and breadth, in the smoothness of the cuticle, and in the snout-like projection of the anterior margin when contracted. He also describes the animalcule as being bent to one side when in the contracted state, and trans-

[1] Ueber der Organisation der Infusorien, insbesondere der Vorticellinen Muller's Archiv. 1856.

versely wrinkled on the concave border. These points, however, do not appear to be of sufficient moment to authorize the establishment of a new species.

A peculiar feature in the ingestion of food was noticeable, which I have observed in no other form. Below the termination of the pharynx was a clear spot (*v*), which appeared to be ciliated on first looking at it, but the ciliation on further examination was seen to belong to certain structures contained therein. On watching it, it was seen to detach itself after a time from the pharynx and pass down the left side of the body close underneath the cuticle, the cilia continuing to work until it reached that point where the body commences to taper off into the foot, where it stopped and gradually disappeared. In the meantime a new spot has appeared at the termination of the pharynx, and it in its turn passes through the same changes. I believe the explanation of this phenomenon is to be found in the manner of feeding. The clear spot is merely an enormous food vacuole, the animal not absorbing its food into the protoplasm of the body, until a considerable quantity of it has been collected, and the apparent ciliation of the vacuole, as stated above, is due to the presence of ciliated forms in its interior. The appearance and disappearance of the vacuole is apparently rhythmical, but this was due to the animalcule being in a situation to obtain a large and constant supply of nutrition, but even then the intervals between the swallowing of the vacuoles varied considerably.

CYCLIDIUM GLAUCOMA, EHERH AND MARGARITACEUM.

These two forms occurred in considerable abundance, particularly the former, which, however, seemed to be rather susceptible to cold, while the latter was not affected. *C. glaucoma* (fig. 3) measures about 0.019 mm., and is covered throughout with bristle-like cilia, which, however, are capable of very powerful action. At the posterior extremity of the body (and not the anterior as has been stated) is the contractile vesicle (*c. v.*), and behind it an extremely long seta. The mouth is situated on the under surface of the body, and is provided with an exceedingly large hood-shaped retractile structure (*h*). These forms collect in large numbers wherever the light shines most strongly. Their motion is exceedingly rapid and jerky; usually remaining at rest, when disturbed one after the

other will give a quick sudden jump, settling to repose again almost immediately.

C. margaritaceum (fig. 4) differs from the preceding in many respects. It presents the same hood-shaped structure *(h)* at the mouth, which is in the same position, but the hood is not nearly as large as that of *C. glaucoma*. It is somewhat large, measuring 0.024 mm., presents a somewhat pearly appearance, and is covered with minute tubercles. The arrangement of the cilia is also very different, the anterior three-fourths being covered with ordinary small cilia, while at the posterior extremity are a few setae. It is constantly in motion, seldom resting, and never moving in the quick jerky manner characteristic of the other form.

The two following forms I observed in water from the University creek, Toronto, which had been allowed to stand for some time, and was almost destitute of green matter.

VORTICELLA MICROSTOMA, EHERH.

The striations in this form (fig. 5) are not easlly seen, but may be observed most readily under oblique illumination. My object in mentioning it is to confirm, or rather partially confirm, a phenomenon observed by Kent. While watching one of these animalcules, I observed it suddenly leave the stalk, which immediately contracted, and swim away by means of the cilia of the disc, not developing a posterior circle as is usual in such cases. The consequences of this action I was unable to follow, as by the next morning the animal was dead. Kent, however, has been able to follow it farther, and states that it encysts, the cyst having a characteristic appearance.

ENGLENA ACUS, EHERH.

This form (fig. 6) occurred in considerable abundance. It was 0.126 mm. in length, and is mentioned on account of the entire absence of the green colouring matter which usually characterizes all members of this genus. The red eye-spot *(e)* was however plainly visible. This was probably owing to their not being able to procure their accustomed food. Kent, in 1880, received specimens from near Birmingham, averaging 0.169 mm. in length, which presented the same peculiarity, which he attributes to the above mentioned cause. His forms were all exceedingly attenuate and stiff in their motions. Certain of the forms I observed were capable of consid-

erable movement, bending the body into a circle, or even twisting it to form a spiral, but still the movements were stiff and ungraceful.

The so-called amylaceous corpuscles, (*c*) on account of the absence of pigment, were remarkably distinct and almost filled the body. They were much elongated. Dujardin imagined these structures to be carbonate of lime, but the occurrence of no effervescence on the addition of strong sulphuric acid at once disproves that supposition. As regards their amylaceous nature, some doubt exists in my mind. The constant association of starch with chlorophyll in the vegetable kingdom, and the similarity between the green colouring of *Euglena* and that of plants, has no doubt to a certain extent led to the supposition. But, as far as I know, no direct experiments as to the decomposition of carbonic acid gas by *Euglena* have proved the colouring matter to be chlorophyll, and further, we have here an individual containing no green colouring matter, and yet possessing large numbers of the corpuscles. Iodine or Iodine and sulphuric acid stain amylaceous substances of a dark brownish-purple colour, and these bodies when subjected to both these substances presented no such reaction, a fact, which, of course, militates rather forcibly against the amylaceous theory.

Guelph, January 25th, 1883.

PLATE.

n. = nucleus. c. v. = contractile vesicle. v. = food vacuole. ph. = pharynx. h. = hood. a. = anal aperture.

Fig. 1.—Metopus n. s. a. c. v. = anterior contractile vesicle. p. c. v. = posterior contractile vesicle. Zeiss obj. D., oc. 4.

Fig. 2.—Schyphidia inclinans, D' Udk. v^1 = food vacuole undergoing absorption. Zeiss obj. J., oc. 2.

Fig. 3.—Cyclidium glaucoma, Ehrh. Zeiss obj. J., oc. 2.

Fig. 4.—C. margaritaceum. Zeiss obj. J., oc. 2.

Fig. 5.—Vorticella microstoma, Ehrh. Hartnack obj. 9, oc. 2.

Fig. 6.—Euglena acus, Ehrh. C. amylaceous (?) corpuscles, e. = eye spot, *m.* = mouth. Hartnack obj. 9, oc. 2.

A TOPOGRAPHICAL ARGUMENT

IN FAVOUR OF

THE EARLY SETTLEMENT OF THE BRITISH ISLES BY CELTS, WHOSE LANGUAGE WAS GAELIC.

BY NEIL MACNISH, B.D., LL.D.

I am of opinion that a topographical argument, so far as such an argument can be regarded as valid and satisfactory, can easily be framed out of the names of the rivers, and mountains, and valleys of England, Scotland and Ireland, in favour of the theory that the branch of the Celtic family whose representatives now are the Gaels of Scotland and Ireland was the first to enter the British Isles; and that those early Celts, after crossing into England from the Continent of Europe at what is now known as the Straits of Dover, extended northward and westward until they reached the extreme portions of Scotland and Ireland. In his edition of Pritchard's "*Eastern Origin of the Celtic Nations*," (p. 57), Latham thus expands the views which Adelung advanced in his "*Mithridates*." "The Belgae, the author, *i. e.*, Adelung, makes Kelto-Germans; and connects them with the Cimbri, the doctrine running thus: That part of Northern Gaul which Cæsar gave to the Belgae, though orginally Keltic, came to be invaded by certain tribes from Germany. These styled themselves *Kimri*, or, as the Romans wrote the word, *Cimbri* . . . Belgae was the name by which the Gauls designated the Cimbri. Some time, perhaps not very long before the time of Cæsar, these Belgic-Cimbri, German in some points, Kelt in others, invaded Britain, *until then an Erse or Gaelic country*, and occupied certain portions thereof until, themselves invaded by the Romans, they retired to Wales and thence to Brittanny. If so, the whole of the British Isles was originally Gaelic. If so, the language of Southern and Central Gaul was more or less Gaelic also. If so, the so-called British branch of the Keltic stock had no existence as a separate

substantive form of speech, being merely a mixture." According to the reasoning of Adelung, therefore, the earliest settlers of the British Isles were those Celts who spoke Gaelic and whose descendants are the Gaels of Scotland and Ireland; and the Cimbri, whose descendants the Welsh are, entered Britain at a later date.

Nicholas, in his preface to *The Pedigree of the English People*, (p. 7), thus writes respecting the argument which he pursues in his book: "It is first shown that the numerous tribes found by the Romans in possession of the British Isles were all presumably of what is called the Celtic race, and presented only such dissimilarities as would arise from separation into independent Clans or States. . . . Although among these numerous tribes, the Cymry may rightfully claim pre-eminence, as that branch of the family which both sustained the heaviest shock from the Teutonic invasion and tinged most deeply the new race with Celtic blood—the Gaels having from remote ages pushed their way northward and into Ireland—the term *ancient Britons* cannot be confined to them, but must be made to comprehend in short all the early Celtic inhabitants of Britain and Ireland."

It is important to notice that in the judgment of Nicholas, the Gaels pushed their way in the far-off past and before the arrival of the Cymry, northward and into Ireland: in other words, that the Gaels arrived before the Cymry in the British Isles, and that entering these Isles in the south of England, they gradually extended to Scotland and Ireland. According to Nicholas (p. 34), Meyer assigns two principal routes to the Celtic tribes in their westward progress from Asia: "One route he traces through Syria and Egypt, along the northern coast of Africa, across the Straits of Gibraltar, and through Spain to Gaul, where it separates into three branches, one terminating in the British Isles, the other in Italy, and the third near the Black Sea. The other great stream of migration ran less circuitously and more northwards through Scythia in Europe, the shores of the Black Sea, Scandinavia, or Jutland, Prussia, through Northern Germany, the plains of the Elbe, and to Britain across the German Ocean. It is conjectured that the stream which came by Africa and Spain was the earliest to reach Britain. They may have been the Gaels."

As to who the Cimbri were, and as to where their home on the Continent of Europe was, Nicholas thus writes (p. 31): "Local

names in Jutland, and words in the vernacular of Schleswig and Holstein, are found to be Cymric. It is difficult to know why the Chersonese should be called Cimbrica at all, except for the reason that the Cimbri abode therein; and it is impossible to account for the belief of ancient historians that this peninsula was inhabited by Cimbri, unless such was the case. Equally difficult is it to account for the adoption of the name Cymry or Cymri by the people now represented by the inhabitants of Wales, unless we allow as the reason their relationship to the ancient Cimbri. The plain account of the name Cymro or Cymru is that it is a modification of Cimbri, just as Cimbri again, according to the testimony of Diodorus, is a slight modification of Cimmerii." Whatever other value the opinions which have been cited respecting the order in which the two divisions of the Celts entered the British Isles may have, a strong expectation will thus be formed that when the topography of these Isles has been closely examined, it will corroborate the theory that the Gaels came at an earlier time than the Cymri from Europe, and that those Celts who still speak the Gaelic language are the descendants or representatives of the earliest Celtic occupants of Great Britain and Ireland. Nor, so far as the value of such a topographical argument is concerned, is it material to determine the question, as to whether there were races in Britain before the Celts made their appearance, the desire being simply to ascertain what the Celtic names of streams, and rivers, and headlands, and mountains, and hillocks have to teach respecting the manner in which the Celts must have spread over the British Isles. In his *Celtic Scotland* (vol. 1, pp. 164, 226), Skene says: "Archæology enables us to trace the previous existence of a people of a different race, indications of which are to be found to a limited extent in the earlier notices of Britain and its topography. . . . The Celtic race in Britain and Ireland was preceded by a people of an Iberian type, small, dark-skinned and curly-headed." It will be generally admitted that the names of rivers, and lochs, and hillocks, and mountains, and headlands, and bays which are to be found in any country, furnish a very useful guide for determining who the earliest settlers of the country were, and who were the earliest races that had sufficient strength and importance, and continuance to leave indelible traces of their presence in the topography of the country. Such names as Ottawa, Ontario, Toronto, Niagara, Caughnawaga, Manitoba, &c., will always pro-

claim that the Indians were at least the earliest occupants of any permanence or strength in Canada, and that whatever alterations may occur in our population owing to the unrest of modern times, the very names of our lakes and rivers will continue to remind us of a time when the Indians had supreme, if not undisputed, sway in our Dominion.

It will frequently be found that the leading names of rivers and mountains are very expressive, enabling us to perceive how very observant those early and untutored tribes were, and how remarkable their success was in framing names whereby the characteristics of stream, and hill, and loch, and headland are pourtrayed with faithful accuracy.

In his article on Gaelic Language and Literature in the *Encyclopædia Britannica*, Dr. MacLauchlan remarks that "Topography is a remarkable source of evidence and one that will be made to serve purposes it has never served as yet." Skene asserts [1]that "the oldest names in a country are those which mark its salient physical features —large rivers and mountains—islands and promontories jutting out into the sea. The names of rivers and islands are usually root-words, and sometimes so archaic that it is difficult to affix a meaning to them. In countries where the Topography obviously belongs to the same language with that spoken by the people who still possess it, though perhaps in an older stage of the language, it presents little difficulty. It is only necessary to ascertain the correct orthography of the names and apply the key furnished by the language itself in that stage of its form to which the words belong. This is the case with the greater part of Ireland and with the Highlands of Scotland, where the local names obviously belong to the same Gaelic language which is still the vernacular speech of its population."

The conjecture is at least pardonable that in the earliest migration of the human race, when the knowledge and ingenuity of men were in the rudest form, and when in the tiny craft that then obtained, even adventuorous races would not care to face the storms of an open sea, the Celts who had their home in Gaul would naturally select the narrowest portion of the strait that divides England from Europe for the purpose of entering the British Isles. *Calais* is a faithful reproduction of *Caolas*—a Gaelic word which signifies

[1] Celtic Scotland, vol I., pp. 212, 213.

a strait, and which in its simplest root *Caol* is of frequent occurrence in Scotland. In such words as Na *Caoil Bhoideach*, the *Kyles* or *Straits* of Bute; *Caol ant-snaimh Colintraive*; *Caol Mhuile*, the *Sound* of Mull; *Caol Ile*, the *Sound* of Islay; *Caol Dhiura*, the *Sound* of Jura, the first syllable *Caol* of *Calais* occurs. In *Baile-Chaolais*, *Ballachulish*, at the mouth of Glencoe in the north of Argyleshire, there is an exact reproduction of *Calais* or *Caolas*. *Baile-Chaolais*, which may be regarded as the Shibboleth of English tourists, means "*the village or hamlet of the strait.*" It is remarkable that there should be so striking a correspondence between the word *Calais* and many words in Scotland which signify *strait* or narrow arm of the sea. In *Colne*, the name of a river in Essex and of another river in Gloucester, compounded as it is of *Caol* and *Amhainn*, *an*, a river, and signifying, therefore, the *narrow* river, we have another example not far from *Calais* itself, of the root which enters into it. There is nothing unreasonable in the conjecture, that the Celts who gave its name to *Calais* and their names to the *Kyles* of Bute, and to many of the straits of Scotland, spoke the same language and were one and the same people.

Dobhar is an old Gaelic word which signifies *water* or the *border of a country*: it has the same meaning in Irish Gaelic. *Dobhar* is found in Scotland in such words as *Aberarder*, the ancient spelling of which was Aberardour, i.e. the *confluence of the water of the height*. Dobhar is also present in the word *Aberdour*, the ancient spelling of which was *Aberdovair*, i.e. the confluence of the water or stream: it is also present in *Aberchirder*, *Aber chiar dur*, the confluence of dark-brown water; and in Calder, which was formerly spelled *Kaledover* and *Kaledour*, i.e. *Coille dur*, the wooded stream. It is quite evident that the word *Dobhar* is of common occurrence in the Topography of Scotland. If we choose to assign to it the interpretation of *the border of a country*, we can discern a fitness in such a designation so far as the Celts of Gaul were concerned, Dover being to them the nearest portion of Britain. In any case, the words *Calais* and *Dover* are purely Gaelic, and have many kindred names in the topography of Scotland. *Cam*, the classical stream of Cambridge, is the Gaelic *Cam*, *crooked*. *Isis*, the classical stream of Oxford, is likewise a Gaelic word. In his *Words and Places*, Taylor maintains that *Isis* is a reduplicated form of *is*, one of the contractions which the Gaelic word *uisge* assumes. "The Isis," he says,

"contains the root in a reduplicated form, and the *Thamesis* or Thames is the *broad Isis*." Whether the interpretation which Taylor gives of *Isis* be correct or not, or whether we may find in that word the root *eas a cascade, an eas*, or a *sios* downwards, there can be little doubt that Isis is a Gaelic word. It is better to regard *Tamh*, the first syllable in *Tamesis*, as meaning *quiet* or *silent*, or as the root *Tabh*, *water*, which occurs in Tay and Tagus.

The rivers Anne, in Devonshire, and Ehen, in Cumberland, come from *amhainn*, the Gaelic word for *river*. Esk, in Yorkshire, and Eskle, in Hereford, faithfully reproduce *uisge*, the Gaelic word for *water*. Devon is a contraction of *da*, two, and *amhainn*, *an*, *river*, and therefore means *two rivers*. The *Exe* in Devonshire, the *Ouse* in Yorkshire, the *Ouse* in Norfolk, and the *Axe* in Somersetshire, are derived from the same root *uisge*, water. Leven, in Yorkshire, is compounded of *liath*, hoary or grey, and *amhainn* or *an*, a river, and means the *grey* river. Don, in the same county, is a compound of *dubb*, black, and *an*, i.e., the black river, or it may simply be from *domhainn*, *deep*. Don is the name of a river in Aberdeenshire, and Doon, in Ayrshire, is the same as Don. Dee, in Cheshire, is compounded of *da*, two, and *abh*, water, *Daabh*, *Deva*, *Dee*, and means *the two waters*. Aire, in Yorkshire, the river on which Leeds is situated, is compounded of *a*, water, and *reidh*, smooth, i.e., the smooth water. It is the same as the river Ayr in Ayrshire, the river Aray in Argyleshire, and the river Arra in Tipperary.

Tyne, in Northumberland, and also in Haddington, is from *teth*, warm, and *an*, a river, the warm river.

Aldie, in Suffolk, is from *allt*, a stream, and *dubh*, black or dark, the black stream.

Lee, in Cheshire, is from *liath*, hoary.

Leen, in Nottingham, is from *liath*, hoary, and *an*, the hoary river.

Stour is the name of six different rivers, and comes from *sturr*, rough, uneven.

Cover, in Yorkshire, is the Gaelic word *cobhair*, froth, and means the frothy river.

Avon, which is the Gaelic word *amhainn*, occurs in many parts of England.

Severn is from *seimh*, smooth or calm, and *burn*, water.

The names of English streams and rivers which have now been adduced, may suffice to show, because they are undoubtedly Gaelic

words, that tribes or people who spoke Gaelic must have preceded the Cymri or Welsh in England; and that one and the same people gave, in the unrecorded beginnings of human settlement in Britain, names to the rivers and streams of England and Scotland. Alterations in the topographical names of England must have been made to a much larger extent than in Scotland or Ireland, in consequence of the successive and powerful waves of invasion that swept over it from the time of the Romans until the Norman conquest.

The Gaelic word *Dun* (*hillock* or *fort*), which is of very common occurrence in Scotland, still survives in many parts of England. In Doncaster, with its Latin termination; in London, whose second syllable is supposed to be *dun*, the hill or fort on which St. Paul's Cathedral now stands; in Dunstable, Dunmore and Dundry in Somerset, the word *dun* is to be found. *Linn* the Gaelic word for *pool* occurs in Lincoln and in Linn, as it does in Loch Linne, in Argyllshire, in Dublin and Roslin. *Beinn* (ben), the well-known Gaelic word for a hill, may be discovered in Penard or Beinnard, *high hill*, in Somerset, (the letters *b* and *p* being convertible), and in Penn in Buckinghamshire. *Ceann*, the Gaelic word for *head*, which occurs frequently in the Topography of Scotland and Ireland, appears in England in Kenne, in Somerset; in Kennedon, (i.e., *ceann an duin*, the head of the hillock), in Devonshire; Kenton, (*ceann duin*, head of the hillock), in Middlesex; Kencet, in Oxfordshire, and Kencomb (*ceann cam*, the crooked head), in Dorsetshire. There is a striking similarity between Cheviot (in Cheviot Hills) and *tiughad*, the Gaelic word for *thickness*. With regard to England, Taylor remarks that "over the whole land almost every river-name is Celtic: most of the shire names contain Celtic roots, and a fair sprinkling of names of hills, and valleys, and fortresses bear witness that the Celts were the aboriginal possessors of the soil."

When we turn our attention to Scotland, we find that over the entire extent of that country,—in the names of mountain and glen, of strath and corry, of pass and headland, of stream, and loch, and river, in sequestered islands, as well as in the heart of large cities and centres of population and industry, words of the purest Gaelic are to be found,—words which serve to connect the present time with the far-off centuries, and to testify that in the Gaelic as the Scottish Highlanders have it and speak it, there is perpetuated the language of those early Gaels, who, before they could leave an

indelible record behind them in the names of streams, and hills, and valleys, must of necessity have held for a long time undisputed possession of the country.

It is noteworthy that, though for more than 1,300 years Gaelic has not been spoken in the South of Scotland, Gaelic words continually occur in the Topography of that part of the Kingdom. A brief reference must here be made to a theory which has as its advocates such scholars as Chalmers in his *Caledonia*, Dr. MacLauchlan and Taylor—the theory that at one time the Cymri occupied the region which was known as Strathclyde; and that the topographical names of that portion of Scotland are Cymric and not Gaelic. Taylor, in his *Words and Places*, thus writes (pp. 257, 258, 259): "The Cymry held the Lowlands of Scotland as far as the Perthshire hills. The names in the valleys of the Clyde and the Forth are Cymric not Gaelic. . . . To establish the point that the Picts, or the nation whatever was its name, that held central Scotland was Cymric not Gaelic, we may refer to the distinction between *ben* and *pen*. *Ben* is confined to the west and north, and *pen* to the east and south. *Inver* and *Aber* are also useful text-words in discriminating between the two branches of the Celts. The difference between the two words is dialectic only, the etymology and the meaning are the same—a confluence of waters either of two rivers, or of a river with the sea. . . . In Scotland the *invers* and *abers* are distributed in a curious and instructive manner. If we draw a line across the map from a point a little south of Inverary to one a little north of Aberdeen, we shall find that (with very few exceptions) the *invers* lie to the north of the line, and the *abers* to the south of it. This line nearly coincides with the present southern limit of the Gaelic tongue, and probably also with the ancient division between the Picts and Scots. The evidence of these names makes it impossible to deny that the Celts of the Scottish Lowlands must have belonged to the Cymric branch of the Celtic stock." By way of refuting the theory which Taylor has thus expounded, in reference to the prevalence of Cymric and not of Gaelic names in the region which was known as Strathclyde, it will be sufficient for my present purpose to cite the conclusions at which Robertson and Skene have arrived after able and mature consideration of the theory in question.

In his *Historical Proofs of the Highlanders*, Robertson thus writes: "The great number of genuine Gaelic names of places that exist in parts which we know were inhabited in the south-west of Scotland by Britons, undoubtedly prove that the Gael had there preceded them, and even lead to the conclusion that the British or Welsh occupation had only begun therein with the invasion of the Romans and under their protection." In his valuable and ingenious work on the Gaelic Topography of Scotland, the same author, after an exhaustive examination of the theory in question, in the discussion of which his Celtic temperament sometimes assumes unnecessary warmth, concludes (p. 99): "that instead of *aber* being, as Dr. MacLauchlan contends, in Scottish topography always joined to pure Welsh words, the truth is that in all Scotland there is not a single *aber* which has Welsh words joined to it. As to Dr. MacLauchlan's second statement that *aber* is never associated with a a Gaelic word, the truth is that in the whole of Scotland every instance where words are joined to *aber* they are Gaelic. The *abers* are as invariably joined to Gaelic words as are the *invers*; and both *aber* and *inver* were used to signify a confluence by the Gaelic-speaking race who originally gave all the Gaelic designations in Scotland, namely, the Caledonian Gael." Skene (*Celtic Scotland*, vol. I., p. 221), effectually disposes of Taylor's theory so far as the dividing line which the latter draws between the region of *invers* and *abers* is concerned. Skene thus writes: "This would be a plausible view, if true, but unfortunately there is no such line of demarcation between the two words. South of Mr. Taylor's line there are in Aberdeenshire 13 *abers* and 26 *invers*; in Forfarshire, 8 *abers* and 8 *invers*; in Perthshire, 9 *abers* and 8 *invers*; and in Fifeshire, 4 *abers* and 19 *invers*. . . . If these words afford a test between British and Gaedhelic, we might naturally expect to find as many *abers* in what was the Strathclyde kingdom as in Wales, but there are no *abers* in the counties of Selkirk, Peebles, Ayr, Renfrew, Lanark, Stirling and Dumbarton, 4 *abers* in Dumfriesshire, 6 in Lothian, and none in Galloway; and when we proceed further south, we find nothing but *abers* in Wales, and no appearance of them in Cornwall." There can be no doubt that the Topography of what was known as Strathclyde is Gaelic and not Cymric, and that Robertson and Skene have successfully refuted the theory of Dr. MacLauchlan and Mr. Taylor. And, even were it

granted that Cymric names occur in the Topography of Strathclyde, it would still be true that the names of streams, and hills, and valleys in that part of Scotland are purely Gaelic.

Taylor correctly observes in his *Words and Places* (p. 203): "That the river-names, more especially the names of important rivers are everywhere the memorials of the very earliest races. These river-names survive where all other names have changed: they seem to possess an almost indestructible vitality." The names of the streams and rivers that occur in the southern counties of Scotland are so manifestly of Gaelic origin, that they refute the theory to which allusion has already been made, *e. g.*

In Wigtonshire are Tarff (*tarbh*, a bull), the wild river. Cree, *criadh*, clay, perhaps owing to the colour of the water.

In Ayrshire are the rivers Ayr, *a*, water, *reidh*, smooth. Doon = Don, *dubh an*, the black or dark river. Girvan, town and river, *garbh*, rough, *an*, river, *rough river*. Irvine, town and river, *Iar*, west, *an*, the west river.

In Kirkcubright are Dee = *da*, two, *abh*, water, double water. Ken, *ceann*, a head. Urr, *oir*, a margin, from the direction in which it flows.

In Dumfries (Dunphreas, *the fort of the copsewood*), Esk, *uisge*, water. Annan, *an*, quiet, and *an*, the quiet river.

In Lanarkshire, Avon, *amhainn*, river, which flows into the Clyde. Douglas, *dubh* and *glas*, grey, the black, grey stream. Kelvin, *coille an*, the wooded river. Clyde = Cliid = Cli, strong.

In Peebles, Esk, *uisge*, water. Lyne, *Linnhe*, pool, as in Dublin, Loch Linnhe. Leithen, *liath*, hoary, and *an*, the hoary river. Earn, *Ear*, east, and *an*, the east river.

In the counties of Roxborough and Selkirk are some of the rivers that have been celebrated by Sir Walter Scott, *e. g.*, Teviot *taobh*, a side, and *aite*, a place, from the course which the Teviot pursues. Ted, *teud*, a string, owing to the straight channel of the river. Gala, *geal*, white, and *a*, water, the white water. Tweed, *tuath*, north, and *aite*, a place, from the direction in which it flows. Yarrow, *garbh*, *gharbh*, rough. Enrich, *an*, river, *riabhach*, greyish, the greyish river.

Those rivers in Strathclyde, whose names have now been given, are purely Gaelic and not Cymric, and therefore invalidate the theory that the Topography of Strathclyde is Cymric.

In the Mull of Galloway, the word *mull* or *maol*, bald, is the same word that occurs in the Mull of Kintyre, and in Malin Head (Maolan), in the north of Ireland. Galloway is Galway in Ireland, and is a compound of *gall*, a stranger, *taobh* or *thaobh*, a side or direction. *Tairbeart*, the Gaelic word for Isthmus, which is of frequent occurrence in the Topography of Scotland, is found near the Mull of Galloway. There are in Wigtonshire such additional Gaelic names as *Glenluce, gleann au luis, the glen of the plant*: Drummore, *Druim mor*, the large ridge: Blairbowie, *blar buidhe*, the yellow plain: Loch Ryan, *reidh an*, the loch of the smooth river: *Machriemor*, the large field: Stranraer, *srath an rogha fheoir*, the Strath of the good pasture.

In Ayrshire are Ballantrae, *Baile 'n traighe* town or hamlet of the shore: *Maybole, magh*, a plain, *baile*, a town, the plain of the town: Mauchline, *magh linne*, the plain of the pool. *Magh* is a common word in the Topography of Ireland, *e.g.*, Armagh, Mayo, Omagh. In Ayrshire are also Dalry, *Dal-righ*, the field of the king: Dunlop, *Dun Luibe*, the foot of the corner or angle: Largs, *Learga*, a plain, and a word of constant occurrence in the phrase *Learga Ghallda*, the Lowland Largs.

In the Valley of the Clyde are Strathaven, *Straven*, the strath or valley of the river; and *Inbhiravon*, the confluence of the river. Melrose is compounded of *meall*, a heap, and *rois, ros* a promontory, the projecting hill. *Eildon* is *eile*, another, and *dun*, a fort, the other fort or hillock. *Linlithgow* is compounded of *linne liath, dhubh*, and accordingly means the grey-dark pool. The examples which have now been given from the Topography of Strathclyde may suffice to substantiate the conclusion, that the Gaels gave names to the rivers and prominent places of that region before the Cumbrians obtained possession of it.

From that portion of Scotland which has always been inhabited by Gaels, it will be well to take a few topographical names merely, if for no other purpose than to show how strong and unmistakable the correspondence is between the names of the rivers and streams of England and of Ireland (as will subsequently be seen), and between those names which are acknowledged alike by friendly and unfriendly critics to be purely Gaelic.

Achadh, the Gaelic word for *field*, is of frequent occurrence in the

Topography of Scotland. Achadhmore, the large field. Achray, *achadh reidh*, the smooth field.

Dal, another name for *field*, occurs in such words as Dalmore, the large dale; Dalness, *dal an eis*, the dale of the cascade; Dalhousie, *dal na h-oisne*, the dale of the corner.

Aber, a word of which mention has been made at some length already, compounded as it seems to be of *ath*, ford, and *bior*, water, water-ford, is frequently found in the Topography of Scotland, *e. g.*

Aberdour, *aber dur*, water: the confluence of the water.

Aberlour, *aber*, *luath*, fast; *dur* = the confluence of the rapid water.

Loch Aber = the loch of the confluence.

Aberfeldy, *aber feathail*, calm: the calm confluence.

Ard means a height, *e.g.*

Airdrie, *ard an righ*, the king's height.

Ardentinnie, *ard na teine*, the height of the fire.

Ardrossan, *ard ros fhonn* = the land of the high promontory.

Ardthornish, *ard thor an eis*, the high cliff of the cascade.

No word is of more frequent occurrence in Gaelic Topography than *amhainn*, Avon, which is supposed to be a compound of *abh*, water, and *-inne*, a channel. In addition to the names of rivers which have been already mentioned in connection with the Topography of Strathclyde such names may be cited as:—

Ness, *an eas*: the water or cascade.

Carron, *car amhainn*: the crooked river.

Nairn, *an ear an*: the east river.

Orchy, *oir*, edge, and *achadh*: the edge of the field.

Leven, *liath an*: the hoary river.

Cona, *cumhann*, *a*: the narrow water.

Bannockburn, *ban cnoc burn*: the water of the white hill.

Baile, a farm, or town, or hamlet, occurs often, *e.g.*

Balmoral, *baile morail*: the stately town.

Balfour, *baile fuar*: the cold town.

Beinn, *ben*, is everywhere to be found in the Topography of Scotland, *e.g.*

Ben Wyvis, *Beinn an uamhais*, the hill of terror.

Ben Nevis, *nimh bhathais*, the hill of the cold brow.

Ben Cruachan, *cruachan*, a hip, the cone-shaped hill.

Ben Mac Dui, *muc dubh*, the hill of the black pig.

Cairngorm, the blue cairn or mound.

Bennan, *Beinn an*, the mountain of the river.

Benvenue, *mheadhonaidh*, the middle mountain.

Benledi, *Beinn le Dia*, the hill of God.

Dun (Dun), a hillock, is an appellative which is present in very many names, *e.g.*

Duneidinn, *dun eidinn*, the hillock of Edwin.

Dundee, *dun dhia*, the hillock of God.

Dunbarr, *barr*, a point, the fort of the point.

Words into which *gleann*, a glen, enters, are very numerous, *e. g.*

Glencoe, *gleann cumhainn a*, the glen of the narrow water.

Glenbervie, *barr bhuidhe*, the glen of the yellow top.

Glengarry, *gath ruith* or *garbh ruith*, the glen of the straight or rough running [stream].

Coille is found in the first syllable of many words, *e. g.*

Kildarroch, *Coille daraich*, the wood of the oak.

Callander, *Coille an darach*, the wood of the oak.

Kill, a cell or Church or burial ground, enters largely into the names of Churches which had graveyards attached to them, *e. g.*

Kilcherran, *kill Ciaran*, the Church of Saint Ciaran.

Killean, *kill, Illeathain*, the Church of the servant of St. John.

Kilmory, *Muire*, the Church of Mary.

Inver, a confluence is supposed to be compounded of *Inne*, a channel, and *bior*, water. The examples of it are numerous in the Topography of Scotland, *e. g.*

Inverary, *inbhir a reidh*, the confluence of the smooth water.

Inversnaid, *snathad*, a needle, the confluence of the needle.

Inveresk, *esk*, *uisge*, water, the confluence of the water.

Inverleith, *liath*, hoary, the hoary confluence.

Loch is the Gaelic word for lake or lakelet, *e. g.*

Loch Aline, *aluinn*, splendid, the splendid loch.

Loch Carron, *car amhainn*, the loch of the crooked river.

Lochee, *I* an island, the loch of the island.

Lochness, *an eis*, the loch of the cascade.

Lochnell, *nan eala*, the loch of the swans.

Loch Laggan, *laggan*, a hollow, the loch of the hollow.

Locheil, *eile*, another, the other loch.

Srath—Strath embraces a wider extent of land than gleann: words into which it enters as a component part are of frequent occurrence, *e. g.*

Strathaird, *aird*, high : the high strath.

Strathglass, *glass*, grey : the grey strath.

Strathearn, *iar an* : the strath of the western river.

Tigh, a *house*, is present in such words as Tyndrum, *tigh an druim* : the house of the ridge.

Tom, *knoll*, forms the first syllable in such words as Tomban, the white knoll ; Tombreck, the spotted knoll.

Torr, a *heap*, appears in such words as Toraven, *torr amhainn*, the heap of the river ; Torantuirc, *torr an tuirc*, the heap of the boar ; Torness, *torr an eis*, the heap of the casade.

Tulach, a *hill* or *knoll*, forms the first syllable of such words as Tullochgorum, the blue hillock ; Tillycoultry, *tulach cul tir*, the hillock of the back of the land.

It is instructive to observe how in the names of the hills and valleys, of the lochs and rivers, of the prominent headlands and picturesque cascades of Scotland, the Gaelic of our time is undoubtedly to be recognized ; and how the strongest link is thus established between the Scottish Gael of the nineteenth century and the Gael of it may be several centuries before the Christian era.

The eary Irish annalists gave unbridled reins to a vigorous imagination for the purpose of tracing the first settlers of Ireland from a very remote antiquity. Dr. Sullivan, in an article on Celtic Literature in the *Encyclopædia Britannica*, thus remarks : "In any case, the time has scarcely come for dissecting and analysing the curious tissues of legends . . . which constitute the mythical parts of Irish history. As in the case of other nations of middle and north Europe, the true chronological history began in Ireland either by contact with the Romans, or with the introduction of Christianity ; and like the mediæval chronicles the genealogists tacked on the pedigree of Irish kins and chieftains to those of Genesis."

The Topography of Ireland furnishes the most satisfactory evidence of purely Gaelic origin, and indicates that those who gave its names to the Topography of Ireland spoke the identical language which is now spoken in the Highlands of Scotland and in many parts of Ireland itself. The Scots, who gave the name to Scotland which it now has, came originally from Ireland. It is maintained that the word *Scot* is the Gaelic *Scuit*, a *wanderer*, and that from *Scuit* the Romans took the designation *Scoti*. Robertson remarks that Ammianus Marcellinus is the first writer that mentions the Scots, and that he

calls them *Scoti vagantes*, i. e., the wandering Scots, proving thus that they could not be natives. Bede calls these marauders *Hiberni*, i. e., Irish, and Gildas says that "the Hibernian robbers return home." As it was only in the beginning of the sixth century that the Scots came to have any permanent home in Albin, it is evident enough that they came too late to have any material influence on the Topography of that country. In his introduction to the Dean of Lismore's book, p. 28, Skene thus effectually disposes of the allegation of Irish historians that the language of the *Scoti* or of Gaelic Dalriada had subsequently to the ninth century spread, with the rule of a Scottish king, over the whole of the Highlands not embraced in that limited territory: "They (the Irish historians) have never attempted to account for the entire disappearance of the previous language, and the expulsion of the previous population of so extensive a district, so mountainous and inaccessible in its character, and so tenacious of the language of its early inhabitants in its Topography, which such a theory involves."

Were it true that the *Scoti*, who eventually succeeded in giving their name to the country which was formerly known as Albin, displaced the Celtic tribes of that country, it is very strange that no word representing *Scoti* has hitherto found its way into the Gaelic language, and that to this day Scottish Celts are wont to say regarding themselves, *Is Albannaich mise*: I am a native of Albin; *Is Albannaich sinne*: We are natives of Albin. Even respecting those inhabitants of Scotland whose blood is not Celtic and whose language is not Gaelic, the Scottish Gael always says, *Is Albannaich iad*: They are natives of Albin. A refutation of the opinion that the Scoti subdued or exterminated the Gaels who occupied Scotland before their time, may surely be found in the entire absence from the Gaelic language of any word representing Scotland.

In turning attention to the Topography of Ireland, I shall, deferring to the extraordinary and sensible importance which Taylor assigns to the names of streams and rivers, first consider the names of the Irish streams and rivers that it may be seen how purely Gaelic they are.

In Antrim are the rivers Bann, a bend or hinge; Bush, *buas*, abounding in cattle; Braid, *braghad*, neck; Main, *min*, soft, gentle; and Don, *dubh-an*, the dark river.

In Londonderry are Roe, *ruadh*, red; Foyle, Feabhal, *fual*, water; Cas, rapid; Esk, *uisge*, water,—the name of a river that occurs in England and Scotland.

In Donegal are the rivers Finn, pale, white; Suilly, *suileach*, sparkling, or *saileach*, willowy.

In Tyrone are Derg, *dearg*, red; Mourne, *muirn*, delight.

In Fermanagh are Erne, *iar an*, the west river; Arney, *iar an*, diminutive west river.

In Sligo, Gara, *garbh*, rough; Easkey, *uisge*, water; Avengorm, the blue river.

In Mayo are Bangor, *beann char*, mountain-winding; Adar, *ath*, a ford, and *dara*, an oak, oak ford.

In Galway, Suck, suction, drawing, and Clare, flat or even, *clar*.

In Clare, Fergus, *fear*, person, one, *gus*, face; Dombeg, *dom*, a house or town, bush, and *beg*, small; Shannon, *sean*, old, *amhainn*, the old river.

In Limerick, Maig, pride or proud gait; Deel, *daol*, a leech; Starr, *storr*, rugged. The river Storr occurs several times in England.

In Kerry, Feale, *fual*, water; Flesh, *fleasc*, lawn or *fleasg*, moisture, *fliuch*; Lanne, *linnhe*, a pool; Roughty, *roichteadh*, a great cry, noise; Avenbui, the yellow river.

In Cork, Lee, *liath*, hoary, a word which occurs often in the river-names of England and Scotland; Bandon, *ban*, white, and *donn*, brown (perhaps); Islin, *is uisge*, water, and *linn*, pool, water-pool. In Waterford, *Suir*, water or river.

In Wexford, Barrow, *bearbha*, still water; Slanley, *slan*, sound, entire; Bann, a bend or hinge.

In Tipperary, Arra, *a*, water, and *reidh*, smooth, the smooth water. Arra is identical with Aire in Yorkshire, with Aray in Argylshire, and Ayr in Ayrshire; Tar, *across* or *tara*, quick; Nier, *an iar*, west.

In Kilkenny, Nore, *an fheoir*, the grass.

In Wicklow, Avenmore, the large river.

In Dublin, Liffey, *liath*, hoary, and *buidhe*, *bhuidhe*, yellow, the hoary yellow river; Dour, *dobhair*, water; the Dover of England, and Dour in Aberdour, and Calder, &c., in Scotland.

In Meath, Aney, *amhainn an*, diminutive of rivers; Boyne, *boinne*, drop or water.

In Louth, Dee, *da abh*, double water. Dee is the name of a river in Cheshire and of several rivers in Scotland.

In Cavan, Annalee, *an liath*, the hoary river.

In Down, Bann, a bend or hinge; Lagan, a hollow.

In Longford, Camlin, *cam*, crooked—the Cam of Cambridge—and *linn*, a pool.

The streams and rivers of Ireland perpetuate purely Gaelic names, names which occur in the Topography of England and Scotland, and which tell that the same people in ages, however remote, gave names to the streams and rivers of the British Isles.

The names of the Irish lochs are generally traceable to Gaelic.

In Fermanagh are Loch Erne, *iar an*, the loch of the west river; Melvin, *meall*, a mass or heap, and *min*, soft, *meall, mhin*; Gill, the *Loch Goil* of Scotland, from *goil* to boil.

In Mayo are Loch Conn, Loch Cuan, the loch of the ocean; Mask, *measca*, mixture or confounding; Loughrea, *riach, riabhach*, grayish loch.

In Clare, Loch Roe, *ruadh*, the reddish loch; Loch Derg, *red*, the red loch; Loch Doo, *dubh*, the black loch.

In Kerry, Loch Allua, *allaidh*, savage or wild loch.

In Cavan, Loch Ouchter, *uachdar*, upper, the upper loch; Loch Sheelin, *sith pass, linn*, pool or water; Loch Neagh, *loch n' eathach;* Loch Gur, *gair, gearr*, short; Loch Foyle, *feabhail, fuail*, water; Loch Suilly, *suileach* or *saileach*.

The names of the islands that lie along the Irish coast are also Gaelic, *e.g.:*

Rathlinn, rath, defence or way, and *linn*, pool.

Innistrahull, innis tri chaoil, the island of the three straits. The last syllable, *caol*, is the first syllable in Calais, and is identical with Caol in the Kyles of Bute, and in Caol Isle, &c.

Torry Island, on the western coast, from *torr*, a heap.

Inishbofin, *innis bofin*, cow white as milk: island of the milk or white cow.

Inishfree, *freadh*, plundering: the island of plundering.

North Inniskea, *sgiath*, a wing; Skye in Scotland: the island of the wing.

South Inniskea: island of the wing.

Innisturk, *torc*, a boar: the island of the boar.

Innishorc, *thorc* of boars; Orkney in Scotland—*Thorc innis* is the equivalent of *innis horc*.

The names of almost all the counties of Ireland are purely Gaelic, *e.g.*:

Antrim, *an druim*: the ridge.

Londonderry, *doire*: a thicket.

Tyrone, *tir Eoghain*: Owen's land.

Donegal, *dun nan gall*: the hillock or fort of the strangers.

Fermanagh, *fear manach*, *monk*, or *fear magh*: the grassy plain.

Leitrim, *liath dhruim*: the hoary ridge.

Sligo, *sligeach*, *shelly*: *slige*, a shell.

Roscommon, *ros*, a promontory.

Mayo, *magh*, a plain, and *o*, yew or beautiful.

Galway, *gaillimh* = *Gallthaobh*: the border of strangers.

Clare, even, flat.

Limerick, *luimneach*.

Kerry, *cearraidhe*, *ciar*, dusky.

Corc, *corcach*, moor, marsh.

Tipperary, *tobair*, *tiobraid*, or *tiprad*, well or fountain, and *ara*, the well or fountain of the river Ara.

Dublin, *dubh*, black, and *linne*, pool: the Linne of Loch Linne and Roslin in Scotland, and meaning the black pool.

Kildare, *coill*, a wood, and *dara*, oak: the oak forest.

Meath, *midhe*, the neck.

Monaghan, *mineachan*.

Waterford: its Gaelic name was *ath lairge*, *ath leargа*, the ford of the plain.

Armagh, *ard-magh*, the high plain or macha.

Down, *dun*: the hillock.

Cavan, *cabhan*: a hollow plain, a field.

The word *cluain*, *cluan*, *cluaine* is often found among the topographical names of Scotland: it means *lawn* or *pasture*. The word *Clune* occurs in Banff, Inverness, Perth, Ayr and Renfrew. *Clune mor* and *clune beg* are in Atholl. *Clunie* and *Cluny* appear in Perthshire, Fife and Banff. *Cluny* in Invernesshire is the name of the home and title of the chief of the Clan MacPherson. The same word, *cluain*, occurs with exactly the same meaning in the Topography of Ireland, *e. g.*

Cloyne, *cluain uamha*, the lawn of the cave.

Clonsost, *sosta*, abode, the lawn of the abode.
Clonfert, *feart*, a feat or action, the lawn of the action.
Clonard, the high lawn.
Clonakilty, *na coille*, the lawn of the wood.
Clontarf, *tarbh*, a bull, the bull's lawn or pasture.
Clonegal, *cluain nan gall*, the lawn of the strangers.
Clones, *cluain eois*.
Clonmel, *cluain meal a*, the pleasant or honey lawn.

Magh, a *plain*, (Anglicised *moy*) enters largely into the Topography of Scotland, *e. g.*

Megginch, *magh innis*, the plain of the pasture.
Mauchline, *magh linn*, the plain of the pool.
Machray, *reidh*, the smooth plain.
Methnen, *fionn*, white, the white plain.
Moidart, *ard*, high, the high plain.
Mochdrum, *magh dhruim*, the plain of the ridge.

Mogh is frequently met also in the topography of Ireland, *e. g.*

Moville, *magh bhile*, the plain of the margin.
Magherboy, *buidhe*, the yellow plain.
Magherros, *ros*, the plain of the promontory.
Mayo, *magh o*, the plain of yew trees or the beautiful plain.
Omagh has the same meaning as Mayo.
Moyluing, *magh luine* = Mauchline, in Ayrshire.
Maylurg, *magh an lurg*, the plain of the end.
Magheralin, *aluinn*, excellent, the excellent plain.

A casual examination of the map of Ireland indicates unmistakably that, in spite of all the alterations that centuries may have effected in the spelling and pronouncing of topographical names, the Gaelic origin of them has by no means been obliterated. The citation of a few additional names will be sufficient.

In Cork, Bantry, *ban traighe*, the white shore; Ballydehob, *da thaobh*, the town of the two sides; Inchgeelagh = the Gaelic pasture; Ballyneen, *an fhion*, the town of the wine; Kinsale, *ceann saile*, the head or end of the salt water; Fermoy, *fear magh*, the grass of the plain.

In Kerry, Kenmare, *ceann mara*, the head of the sea; Killarney, *coill fheurnaidh*, the alder wood; Dunmore, the large hillock; Ardfert, the high land; Tarbert, *tairbeart*, isthmus; Tralee, *traighe liath*, the hoary shore.

In Limerick, Kenry, *ceann righ*, king's head.

In Clare, Ennis, pasture, *innis*; Kilrush, *coill ros*, the wood of the promontory; Killaloe, *da lua*, the cell or wood of the two heaps; Dromore, the large ridge; Ballyveaghan, *bheagan*, few, the town of the few; Killediseirt, the wood of the desert. Galway; Kenmarra, *ceann mara*, the head of the sea; Gort, garden, standing corn; Oranmore, *odharanmor*, the large cow parsnip; Glenamaddy, the glen of the dogs.

Mayo, Ballyhannis, *sanas*, the town of the warning; Ballina, *ath*, the town of the ford; Killamagh, the wood of the plain.

Sligo, Dromore, the large ridge; Drumkeeran, *druim ciar*, the dusky ridge.

Leitrim, Carrick, a rock, *carraig*.

Tyrone, Strabane, the white strath; Omagh, the beautiful plain or the plain of yew trees; Aughnacloy, the field of the stone.

Donegal, Malin, Maolan, *bare*, Mull; Donros, *dun rois*, the fort of the promontory; Leck = a stone; Innishowen, Owen's isle.

Londonderry, Limavaddy, the dog's leap; Kilrea, *riabhach*, the grayish wood; Tobermore, the large well.

Kildare, Clane, *cluain*; Athy, *ath*, a ford; Ballytorc, the town of the boars.

Tipperary, Ballina, *ath*, the town of the ford; Roscrea, *ros criadh*, promontory of clay; Cahir, a city.

Antrim, Port Rush, *rois*; Carrickfergus, the rock of Fergus; Crumlinn, *crom*, bending, *linn*, pool; Lisburn, *lios*, garden or fort, *burn*, water.

Down, Bangor, *beann char*, the bend of the hills; Dundurm, the foot of the ridge; Ardglass, *glas*, the grey height.

Meath, Dunleek, *dun leac*, the foot of the stone; Drogheda, *drochaid ath*, the bridge of the ford; Dunboyne, *dun boinne*, the fort of the Boyne.

Wicklow, Donard, *dun ard*, the lofty hill fort; Ballymore, the large town or hamlet; Rathdrum, *rath druim*, the foot of the ridge.

Kildare, Naas, an assembly; Ballytorc.

It may without any hesitation be asserted that, when regard is had to Ireland as a whole, its topographical names are more commonly and consistently and plainly Gaelic than those of either England or Scotland. It is impossible to resist the inference that the same people who gave names to Calais and Dover and

to the streams and rivers of England, who gave names to the streams, and rivers, and lochs, and mountains, and headlands, and valleys of Scotland, must have been the same people who gave names to the streams and rivers, to the lochs and mountains and hillocks, to the headlands and valleys of Ireland. So far as a topographical argument can be admitted to be of much avail or consequence—and it is difficult to understand why, in the determining of questions that affect the settlement of countries in the far-off past, great value ought not to be attached to topographical names it must be conceded that, without considering the presence of a previous race in the British Isles, there is sufficient evidence that the Gaels preceded the Cymry, and that in England, Scotland and Ireland the Gaels have left indelible traces of their presence at a remote time. There is certainly very much to justify the conjecture of Nicholas, who, in his "*Pedigree of the English People*," (p. 46), thus writes: "In the absence of historic record, we are justified in presuming on grounds of antecedent probability that Ireland would receive its first inhabitants from Wales or Scotland. Wonderful explorers were those ancient Celts. Probably they soon pushed their way through thicket and swamp to the Highlands of Scotland, and finding there an end to their territory, they there, from the highest eminences, looked out westward and descried the misty coast of the Green Isle. The first tribes to arrive in Britain would probably be the first settlers in Scotland and Ireland. Pressed toward the interior by subsequent arrivals, nomadic hordes but slightly attached to any particular spot, they would readily move forward to new pasturages rather than long contend for the old. The Gaelic or Gadhelic people, therefore, may be presumed to have had the advantage of priority of occupation." Aristotle, the first writer who refers to Britain, says: "Beyond the pillars of Hercules, the ocean flows round the earth, and in it are two very large islands called British (βρεττανιχαι λεγομέναι) Albin and Ierne lying beyond the Keltoi." By the term *Albin* Aristotle must have intended that portion of the British Isles now embraced by England and Scotland. The Scottish Gaels still speak of their country as Albin, and of themselves as *Albannaich*, thereby showing that, if there is any force in the reference of Aristotle, they are the representatives of the earliest inhabitants of Albin, or of England and Scotland.

The topographical argument in favour of the peopling of the British Isles by the Gaels may be thus briefly expressed: Calais and Dover are Gaelic names which must have been given by Gaels who were in the habit of crossing at those points from the continent of Europe to the British Isles. Along the eastern coast of England there are indelible traces in the names of streams, and rivers, and hillocks of the presence of the Gaels. Owing to the powerful wave of invasion that successively rolled over England until it was subdued by William the Conqueror, Gaelic names, which doubtless were given to what is now the site of English towns and cities, were superseded by names of Roman origin, or by names which the later invaders chose to give. That such an opinion is correct may readily be seen by looking carefully at the map of England. That portion of Scotland which lies south of the Friths of Forth and Clyde was subjected from the time of the Roman invasions to inroads from other nations, and, as a natural consequence, the topographical names are not so commonly Gaelic as in the Highlands. A close similarity obtains between the topographical names of England, of the south of Scotland, and of the Highlands of the latter country; whence the inference may be drawn that the Scottish Gaels are now the representatives of those Celts who were the first to enter Britain, and to travel northwards from the south of England to the north of Scotland. From an examination of the Topography of Ireland, the inference may fairly be drawn that the same Gaelic race must have peopled that country, and that the Scottish Highlanbers of to-day can extract satisfactory evidence from the topographical names of Ireland to convince them, that their own remote ancestors and the Celts, who were the first to people Ireland, were one and the same people, and spoke the same language.

The topographical argument which has been now examined, leads to the conclusion, that the first powerful stream of immigration into the British Isles was Gaelic; that it entered the south of England and extended northwards and westwards; that from Scotland, where its branches were widely scattered, it passed into Ireland, and left there numerous and indelible proofs that the same Celts who gave names to Calais and Dover, gave also names to Innistrahull and Durrow, to Ballachulish and Aberdour; and that the same Celts who gave names to Fintry and Bannockburn in Scotland, gave names also to Bantry and Kinsale in Ireland.

ON THE OCCURRENCE IN CANADA

OF

TWO SPECIES OF PARASITIC MITES.

BY J. B. TYRRELL, B.A., F.G.S.

Sarcoptes minor, var. Cati, *Héring.*

A short time since my attention was called to a cat whose face had apparently been scratched and torn and was now covered by a moist scab, which was especially noticeable at the base of the nose and around the eyes; however, on turning back the hair from the top of the head and base of the ears the same diseased condition was seen to prevail, though not to such a marked extent.

On removing the scab, the skin was found to be completely honeycombed, presenting the appearance of coarse cellular tissue, in the cells of which, and among the roots of the hair which had been pulled out with the scab, could be seen a number of exceedingly small white specks which, when picked up on the point of a needle, and placed under the microscope, proved to be a small itch-mite belonging to the species described by Fürstenberg as *Sarcoptes minor* (S. cati, Héring; S. notoëdres, Bourguinon and Delafond). It is the smallest species as yet described, not being more than half as long as Sarcoptes scabiei, the common itch-mite which infests man.

As this minute parasite has in many places proved very fatal to our domestic favourites, it will be interesting to notice shortly the peculiarities of its structure, and then to look for a moment at the way in which it commits its depredations.

The general shape of the body is almost globular, being slightly longer than broad, the female being about .12 mm. long and .1 mm. broad, the male somewhat smaller. To the naked eye it appears as a shining white spot, but under the microscope it has a grayish white appearance with light brown colored markings, showing the position of the chitinous skeleton.

The body is, as in S. scabiei, covered with a thin transparent epidermis raised into minute folds, which follow more or less closely

the outline of the body, or rather circle round the anus, which, in this species, is placed almost in the centre of the back. As the folds approach nearer the anus they become less and less continuous, becoming first rows of rounded papillae, and then disappearing almost altogether. Towards the anterior end of the dorsal surface and near the median line are two short spines, one on each side; and a somewhat shorter one is present on each side near the lateral margin. On each side of the anus there are two curved rows of short, blunt bristles, forming a kind of double arch over it, and made up, the outer one of four, the inner one of two bristles on each side. These point in a general way backwards and inwards towards the anal opening. Anal bristles on the posterior end of the body are entirely wanting.

The dorsal position of the anus is very peculiar, and it was this that suggested the name "notoëdres," which Bourguinon and Delafond applied to this species. It is strange that the peculiarity should have escaped the notice of earlier observers, as it is very well-marked. Fürstenberg, who has given some very fine figures of this species, takes no notice of the dorsal opening, but indicates an opening on the ventral surface where none exists.

At the anterior end of the body is situated the rostrum, composed of the following parts: A pair of biting three-jointed mandibles, the third joint springing from the side of the second and growing out to an equal length with it, the opposed edges being furnished with blunt serrations, thus forming strong nippers on each side of the mouth. Below these are the immovably united maxillae with their three-jointed palps, which extend forward parallel with the mandibles. A thin fold of the integument surrounds the whole, enclosing it in a kind of sac open in front, called by Robin the *camerostomum*. Viewed from the dorsal surface a portion only of the rostrum is seen, as it is partially covered by a fold of the skin which projects over it.

The body is provided with four pairs of five-jointed legs, two anterior and two posterior, the anterior arising from the antero-lateral margins of the body, the posterior from the hinder portion of the ventral surface. The first four joints of these legs are surrounded and strengthened by rings of chitin of a more or less irregular shape, and are armed along their sides with bristles whose positions are constant in the same species. The fifth joint is covered with a

cone-shaped cap of chitin supporting the terminal processes. The two anterior legs on each side bear at the extremity of this latter joint four curved hook-like claws, and a relatively large bell-shaped sucker on a stem which, though long, is much shorter than in S. scabiei. In the female the posterior legs are terminated by long flexible bristles in place of suckers. In the male the third leg only ends in a bristle, the fourth bearing a long-handled sucker very much like that on the first and second legs. The legs articulate with and are supported by the *epimera*, which are light brown chitinous bands present in the walls of the body and extending in a general way along the ventral surface from the points of insertion of the legs towards the median line. Those of the front pair of legs run backwards and inwards, and, a short distance behind the rostrum, unite to form an elongated Y-shaped figure. The arms of the Y, however, are bifurcated, the anterior branch running forward to support the palps, the posterior articulating with the first leg. The second epimere also runs backwards and inwards for a considerable distance, but before reaching the median line it takes a sharp turn outwards and terminates abruptly. The third and fourth epimera in the female are short and slender, running forwards and inwards, and bending towards each other at their anterior ends. In the male the arrangement is more complicated; the third and fourth epimera run forwards and inwards joining the anterior portion of the *sternite*, a median chitinous band which runs backwards along the posterior portion of the ventral surface, thus enclosing the male sexual organs under a sort of double arch, the keystones of which are prolonged until they meet each other.

The external sexual organs in the male are situated between the points of insertion of the fourth pair of legs, and are composed essentially of the three following parts: (1) the *sternite*, composed of a chitinous band on each side of the sexual opening, which runs forward and joins the one from the opposite side in front of the opening and becomes continuous with the median chitinous strip mentioned above; (2) a lid or *hyposternum*, made up of two arched bands and a connecting membrane, thus forming a triangular cover hinged to the sternite at its postero-lateral angles, and with the point directed forwards; and (3) a *penis*, which, when prone, is directed forwards under the episternum and may be seen through

it, but in copulation it is turned backwards, when, of course, the episternum is also turned back beneath it.

The external sexual organ of the adult female is simply a narrow slit running across the under surface of the body, about half way between the insertions of the second and third pairs of legs. It is rather an interesting fact, however, that the male does not copulate with the fully developed female, but with the female in what has been called the *nymph* stage, when the ventral opening into the oviduct has not yet appeared; another ecdysis being necessary before the adult form is assumed. I have not had the opportunity of observing the mode of copulation, but there would appear to be no doubt that the anus serves for the opening both of the intestine and the vagina. Fürstenberg, in his comprehensive treatise on "Die Krätzmilben," does not mention the opening in the middle of the ventral surface, but in Sarcoptes scabiei figured the oviduct as opening into a cloaea along with the intestine, evidently not recognizing the fact that the oviduct and vagina opened at different parts of the body. He also states that he saw a male and female in copulation, and that the penis was inserted into the anal opening.

In the closely allied family of the "Dermaleichidae" also, the arrangement of the female sexual organs is essentially as follows:—There is a post-anal opening leading by a duct into the *Receptaculum seminis*, which opens into the oviduct, at one end of which the ovaries are placed, and the oviduct opens on the middle of the ventral surface. It appears very probable that an arrangement of the parts similar to the above exists in the genus Sarcoptes.

With the exception of the absence of a ventral sexual opening, and the slightly more posterior position of the anus, the nymph is very similar to the adult female.

The larva is somewhat smaller than the nymph, and is only provided with six legs, the hinder pair of which end in long bristles as in the adult females.

The egg is small, oval or somewhat ovate, and about half the length of the adult female.

We have adopted Fürstenberg's name *minor* for this species instead of *cati*, which had previously been given to it by Héring, as the first is characteristic of the species itself (it being very small), and not merely of its habitat, for though it was first found on the cat, it has since been found on the rabbit and other animals. On

the rat, for instance, M. Mégnin has found a species of Sarcoptes which differs considerably from the one on the cat, but which he has shown to be only a variety of the same species, therefore we retain Héring's name *cati* for the variety from the cat, and adopt the name *muris* for that from the rat.

This little parasite first attacks the cat at the base of the nose, around the eyes, and at the base of the ears, where it forms small white pustules in which the mite may be found. From these points it spreads over the whole head, then it is stated to work backwards over the neck, and finally over the whole body, reducing the poor animal to the last stages of leanness and decrepitude. M. Mégnin, however, states that the mite does not attack any other parts of the body, except the head and neck. As I have not had any opportunity of observing cats which have been a long time diseased, it is impossible for me to say at present which of these statements is correct.

It has been asserted by some authors, who have no doubt drawn their conclusions from analogy to Sarcoptes scabiei rather than from direct observation, that this mite bores long and tortuous passages through the skin among the roots of the hair, but an examination of the diseased parts shows, not a number of winding passages filled with eggs and fœces, but a great number of round, cell-like cavities, in which the adult female is lying surrounded by several eggs and a quantity of fœcal matter, showing clearly that the mite has been in this nest for a considerable time. The male and young are not found imbedded in the tissue, but scattered through and under the scab and on the surface, when the copulation evidently takes place. After impregnation the *nymph* then bores into the tissue, takes on the form of the adult female, and lays her eggs in the nest which she hollows out for herself. In parts of the animal which have been long affected, these nests are packed together so closely as to be almost in contact.

It only remains for us to mention some of the remedies which have been recommended for the cure of this disease, always, however, bearing in mind the fact, that on account of the excessive sensitiveness of the skin of the cat, many of the washes and lotions, which would be exceedingly useful when applied to other animals, would in this case probably prove hurtful or even fatal.

Sulphur is the most generally useful insecticide, and where the mite can be reached by it, there is no doubt but that it will effect a

cure. Sulphur ointment applied repeatedly to the diseased parts is said to effectually destroy the pest. A solution of Balsam of Peru in alcohol, applied carefully, has also been highly recommended.

PSORERGATES SIMPLEX, N. G. & SP.

While engaged in the study of Sarcoptes minor, a mouse was brought to me which had a crusty scab on the lower part of the back of the ear, extending round its outer edge and into the interior of the conch, where it assumed the appearance of a tough, leathery skin of a dirty grey colour. When a piece of this scab was pulled off with the forceps and placed under the microscope, a number of small mites were seen crawling over and burrowing their way into it. At first sight they appeared to me very much like small, short specimens of *Myobia musculi*, but a more careful study showed them to be separated by many marked characteristics from this latter species. It was seen, too, that they were all males, and that a further search must be made for the females and young. I therefore placed the scab in glycerine and tore it to pieces with needles, and in this way brought to view a number of round, white specks, which proved to be the females, nymphs and larvæ, resembling the male in very little else but the structure of the rostrum and the even distribution of the feet along the sides of the body.

This is in all probability the species mentioned by Gerlach, in a book entitled "Krätze and Räude," published in 1857, as occurring on the ear of the common mouse, though on this point I am unable to speak positively, as I have had no opportunity of seeing the original description and figures. As M. Megnin, however, in his invaluable work on "Les Parasites et les Maladies Parasitaires," says that it is impossible to determine from the original figure even to what family this mite belongs; and as neither Megnin, in the book just cited, nor Gerstäcker, in his review of Gerlach's work in "Archivs für Naturg eschichte," make any mention of a name having been given to it, and as Fürstenberg in his extended synopsis of *Krätze and Räude* does not even notice the fact that an itch-mite had been recorded from the mouse, it seems advisable to publish a new description of it and give it a name. If it appears afterwards that it has already received a name, the one now used will of course be abandoned and the previous one adopted in its stead.

In colour the body, over the greater part of its surface, is of a dirty white, though the epimera and the chitinous bands which encircle and support the legs are tinged with light yellowish-brown. In shape the two sexes differ very much. Looking at the dorsal surface the general outline of the male is ovate with the obtuse pole directed forwards and rather strongly truncated, and from the middle of this anterior end projects the conspicuous and almost quadrangular *rostrum*, close to which on each side the anterior extremities take their origin and point when at rest obliquely forwards and outwards. The lateral margin of the body is marked by three constrictions dividing it into four sub-equal segments, each of which bears a pair of legs, hence the legs are arranged at almost equal distances from each other along the sides of the body. This character creates a marked distinction between this species and those of the genus Sarcoptes, in which the legs, instead of being situated at equal distances from each other, are arranged towards the anterior and posterior ends of the body, a considerable distance separating the insertions of the second and third pairs. On the other hand it appears to point to a general relationship with the genus Myobia, which further examination only serves to strengthen, though the form of the female and the general course of development remove it very far from this genus. The surface of the back is considerably arched, rounding off along the sides into the belly which is flattened towards the anterior end, but deeply hollowed out from the level of the insertion of the second pair of legs backwards, evidently for the purpose of receiving the female during copulation. In the female the general shape is very different from that of the male. The body is almost globular, being rounded on both the ventral and dorsal surfaces; the rostrum projects but very slightly beyond the anterior end, and the legs are represented merely by little knobs situated along the sides of the body. The male averages about .12 mm. in length and .1 mm. in breadth. The female is not quite as large, both length and breadth being about .1 mm.

The body is covered with a thin, soft skin, which is smooth or irregularly dotted over the greater part of the ventral and dorsal surfaces, but along the sides in the male a few fine wrinkles can be made out, following in their course the general outline of the body. Imbedded in the skin are the epimera and the chitinous supports to the legs, which will be described below. The skin is thus very like

that of Sarcoptes scabiei, except that the wrinkles are much fewer and finer. At the anterior end of the body the organs of manducation are grouped together into the form of a sub-quadrate *rostrum*, which projects considerably beyond the front of the cephalo-thorax, though it is, to a certain extent, retractile under it. The rostrum, seen from the dorsal surface, is somewhat rectangular in outline, the outer angles being slightly rounded off and the line of the front curved outwards to a certain extent. Its length is considerably greater than its breadth, being on an average about 0.025 mm. broad and 0.015 mm. long. It is composed essentially of the following parts, viz.: (1) A long delicate *lingua*, or tongue, which, however, is very difficult to discern clearly until the animal has been submitted to strong pressure, when it sometimes may be seen as a stout bristle projecting beyond the anterior margin. (2) A pair of long, acutely conical unjointed *mandibles* running parallel and close together during the greater part of their length, and apparently forming a sheath for the median tongue. (3) A pair of *maxillæ* firmly united at their base, but bearing at their outer and anterior angles a pair of two jointed palps, one on each side of the mandible, the first joint being large and sub-rectangular, the second small and conical. Towards the side from the insertion of the palp, the angle of the maxilla is extended into a short spine. With the exception of the characters which we have just enumerated, namely, those of the skin and of the rostrum, and perhaps also those of the digestive canal, which however we have not been able to make out, the male and female present an entirely different appearance, and it will be most convenient to consider them separately.

In the male, which as stated above is flattened from above downwards, the legs arise on the ventral surface a short distance in from the lateral margin, so that the first and part of the second joints are hidden from view when looked at from above. The number of joints present in each of the legs is four, the second probably corresponding to the second and third in Myobia musculi, and other closely allied species. They are all strengthened by very light brown rings of chitin which encircle them and form points of attachment for the flexor muscles. The first joint in all the eight legs is somewhat triangular in outline, the base of the triangle, which is the side nearest the middle line of the body, being somewhat incurved, with the angles adjacent to it slightly rounded, the anterior angle running

forwards for a considerable distance to articulate with the epimera. The second joint is large, with a long and strongly curved outer and a short inner margin. On the outer side, but rather towards the dorsal surface of this joint, three small tubercles are present, bearing at their ends as many short bristly hairs. These are most strongly developed on the first and fourth legs, not being so conspicuous on the second and third. The third joint is smaller and more nearly round, though somewhat longer on its inner than on its outer border. On this latter border there is a short tubercle and spine present on the first leg, and a pair of blunt spineless tubercles on the fourth. Articulating with the distal end of the third joint is the fourth joint or tarsus, which at its proximal end is comparatively narrow, but after a short distance it suddenly increases to about double its original breadth, forming on the inner side of the first leg a backwardly projecting spine, which, however, is not present in the other extremities. After thus enlarging the tarsus does not again contract, but continues of about the same size to the end of the joint, when it is sharply truncated, the end being straight or even slightly incurved. In this emargination, but rather towards the dorsal surface of the joint, a short blunt spine takes its origin. On the same joint, but on the extreme outer angle, there is also present a rather strong, slightly curved claw, of about the same length as the spine and with it giving to the leg the appearance of being terminated by two claws. Besides the spine and claw the tarsus is armed with two bristles, one on the inner and one on the outer side.

Situated immediately under the thin transparent epidermis, and imbedded in the tissues of the body, the epimeræ, which are composed of strips of light-brown coloured chitin, extend from the anterior angle of the base of the legs towards the middle line of the body, and form with the small pieces of chitin behind the rostrum the framework or skeleton of the trunk. Their principal functions are to serve as supports for the legs and to form points of attachment for the muscles which move them. Those of the anterior pair of legs arise on each side of the rostrum and close to it, and run backwards and inwards for about one-fourth the length of the body, not meeting to form a point, however, as in Sarcoptes minor, but turning sharply outwards and ending abruptly. Those of the second, third and fourth legs are also each of them present as detached bands. The

anus is present as a longitudinal slit on the posterior end of the body.

The sexual aparatus is situated between the insertions of the fourth pair of extremities, and is composed of two bands of chitin running backwards along the ventral surface, each having the appearance of two segments of circles placed end to end, one behind the other, the posterior including more of the circumference of the circle than the anterior. Between these two longitudinal bands the penis is present as an elongated cone, directed towards the posterior end of the body. Epidermal appendages are very poorly represented, the only ones of any importance being two long bristles which arise one on each side from the posterior end of the sexual chitinous bands, and extend a considerable distance beyond the hinder end of the body. Besides these there are the small bristles or hairs on the legs which have been already mentioned.

The structure of the female is exceedingly simple, having the appearance externally of a minute white ball, with the sub-rectangular rostrum projecting from its anterior surface. The feet, which occupy the same positions as in the male, are, however, very much smaller and quite useless for walking on a level surface, though probably very effective in boring through the soft tissues of the ear of their host. They are composed of but two short joints, the first of which is almost immovable, and is united by a triangular chitinous base of attachment to the skin of the body; the second is of a rounded triangular shape, and is movably articulated to the first. Epimera are present, but are very small, their place being taken functionally by the chitinous base of the legs. The surface of the body is smooth, no bristles or spines of any kind being present either at the posterior end or on the diminutive legs. The anus is at the hinder end of the body. The opening from the oviduct is in the form of a simple transverse slit on the ventral surface, a short distance behind the base of the rostrum.

The course of development of this aberrant form of itch-mite is very peculiar, for though in its adult condition it bears considerable resemblance to Dermatoryctes fossor, so carefully described by Prof. Ehlers in Zeit. f. w. Zool. Bd. XIX., yet it differs essentially from this latter, in the fact that the larva closely resemble in general form the adult female rather than the adult male, thus leading one to suppose that the male was a farther development of a mite like the

female, and not that the female was degraded by more complete parasitism from a mite possessed of the higher type of structure presented by the male; thus the nymph or unimpregnated female is very much like the adult female, except that it is slightly smaller, and there is no ventral opening to the oviduct, and the larva also is very like the female, except that the fourth pair of legs have not yet appeared. The egg is more or less irregularly, oval in shape, and somewhat more than half as long as the adult female.

It will be seen from the above description that the mite found on the ear of the mouse differs considerably from any forms already described, resembling Dermatoryetes fossor (Ehlers) in the simple character of the female, but resembling much more nearly Myobia musculi in the structure of the rostrum and the general form of the male. It also differs from D. fossor in being oviparous and not viviparous.

Considering all the circumstances, it has appeared to me advisable to create for its reception a new genus, with the following characters:

PSORERGATES, *n. g.*

Ψωρα, a scab; ἐργατης, a builder.

General shape of the male and female quite different, the male being provided with legs which are terminated by a spine and claw, in the female the legs are very small and without terminal appendage, Mandibles styliform. The nymph and larva resemble the female rather than the male, Oviparous.

PSORERGATES SIMPLEX, *n. sp.*

Characters enumerated above.

Its habits were mentioned in the first part of this paper, namely, that it has been found living under a soft scab for the most part inside the conch of the ear of a mouse (*Mus musculus*); but attention must be drawn to the circumstance that the male, though very active, and often found on the surface of the scab, must also bore into and under it in order to copulate with the nymph, which, from the shortness of its legs, would be unable to move outside the tissues of its host. In this particular it differs essentially from Sarcoptes minor, in which it will be remembered the nymph is active and moves about on the surface; and it is only after copulation that it bores into the tissue and assumes the adult form.

DESCRIPTION OF PLATES.

PLATE III.

SARCOPTES MINOR, VAR. CATI.

1.—Adult female, ventral surface × 250.

2.—Male, ventral surface × 250.

3.—Nymph or immature female, dorsal surface (it very closely resembles the adult female, except that in this latter the anus is nearer the centre of the back), × 250.

4.—Six-legged larva, dorsal surface × 325. (After Fürstenberg. The anus has, however, been drawn on the dorsal instead of on the ventral surface).

5.—Rostrum of S. minor, var. muris, × 600. (After Mègnin).

PLATE IV.

PSORERGATES SIMPLEX.

1.—Male, dorsal surface.

2.—Male, ventral surface.

3.—Adult female, ventral surface.

4.—Nymph, or immature female, ventral surface.

5.—Larva, ventral surface.

6.—Rostrum, showing palps, mandibles and tongue.

7.—Egg.

All the figures magnified 435 times.

SOME OF THE PRESENT ASPECTS

OF THE

GERM-THEORY OF DISEASE.

[The following is a summary of a popular Lecture given by Prof. Wright under the auspices of the Canadian Institute on the Germ-Theory of Disease. The Lecture was intended mainly to elucidate the subject from a biological point of view, and reviewed the interesting facts which have been contributed to the Natural History of the lowest Fungi by researches into the relationship of microscopic organisms to Disease. The present synopsis may be of interest to the members of the Institute.]

During the last ten years a host of investigators have been busy in different parts of the world in attempting to discover the causes of certain forms of disease, and their labours have been so far attended with success that in almost all forms of contagious and infectious diseases, and in certain others which have not been included in that category, minute organisms of a special form have been found constantly associated with the particular diseases. The thought, of course, lay upon the surface that these organisms are not only the originators of the disease, but are simultaneously the means of spreading it. Such, indeed, has turned out to be the case. It is indisputably proved by means of laborious experiments that in some diseases the minute organisms are entirely responsible for all the course of the disease; and it is reasonable to conclude that when the same methods have been applied to the study of other diseases, a connection of the same nature will be demonstrated.

The first discovery affording a substantial basis for a Germ-Theory of disease was made more than twenty years ago by Casimir Davaine (who died in Paris towards the close of last year). He found in the blood of animals affected with Anthrax[1] a rod-like organism (now known as *Bacillus anthracis*), in immense quantities, which, accustomed as he was to the investigation of diseases caused by

[1] This disease, also known as Charbon, which has produced immense ravages especially among sheep and cattle in Europe is fortunately very little known in Canada. Isolated cases, however, have been recorded both from Ontario and Quebec, chiefly horses having succumbed to it.

internal parasites, he had no hesitation in accusing as the cause of the disease.

The actual proof of this, by separating the organism, cultivating it free from anything to which the disease might be ascribed, and subsequently producing the disease in a healthy animal by innoculation of such pure cultures, was delayed for many years. Nevertheless, Davaine's was an epoch-making discovery, and the insight which has been gained into the relationships between microscopic organisms and disease is very largely owing the classical researches of Pasteur, Koch and others on Anthrax. To these and similar researches biology is much indebted for additions to the knowledge of the group of Fungi to which these disease-producing organisms belong, and enquiries into the natural history of the group as a whole have been thereby stimulated, which have led to many interesting results. The present paper is intended to indicate a few of the most important of these.

Although the function of the green-colouring matter of plants cannot yet be regarded as definitely established,[1] coloured forms are nevertheless known to be able to draw their carbon from the carbonic acid of the medium in which they live, while colourless forms depend on living or dead organic matter for their food, and are thus either parasites or saprophytes. Most of the colourless plants belong to the lowest vegetable sub-kingdom (the Thallophytes), and constitute the class Fungi of that subdivision. Coloured and colourless Thallophytes exhibit various grades of organization, but with the exception of the Mould-Fungi all of the organisms which produce disease belong to the lowest grade, which reproduce themselves mainly by division or fission, and have on this account received the ordinal name of Schizophytes.

Among the Mould-Fungi both parasitic and saprophytic forms are to be found. Many diseases of plants are attributable to the former, and not a few of those incident to the surface of the body in animals. Under ordinary circumstances the interior of the body is not favourable to the development of moulds: not only is the temperature too high, but the alkaline reaction of the fluids and the scarcity of oxygen are both factors which hinder their growth. It is otherwise with the colourless Schizophytes; the conditions which

[1] Recent researches appear to indicate that Chlorophyll protects the first products of assimilation against the decomposing action of light.

interfere with the development of the moulds are favourable to them, and it is consequently with this group that we have alone to concern ourselves in connection with the Germ-Theory of Disease. The colourless Schizophytes or *Schizomycetes*, as they are also termed, present many difficulties to the investigator on account of their extremely small size.[1]

Various generic forms have been distinguished, such as *Micrococcus*, embracing the minutest globular or oval forms often in chains; *Bacterium*, short, rod-like forms; *Bacillus*, longer rods; *Leptothrix*, long jointed threads; and in addition various spiral forms, *Spirillum*, *Spirochate*. The constancy of these forms has been defended by some authorities and denied by others, but the recent researches of Zopf on Cladothrix and Beggiatoa indicate that all of these so-called genera may be merely different stages of development of higher members of the same group of Fungi. Thus the thread-like Cladothrix and Beggiatoa, two of the commonest aquatic fungi of cosmopolitan occurrence, give rise in the interior of the threads to Micrococcus or Bacterium-like spores which may grow out into Bacillus- and Leptothrix-like forms, or may first multiply themselves rapidly in a motionless or zoogloea condition. Again in both the adult threads may undergo a retrogressive development, becoming divided up into shorter or longer pieces (Bacillus- or Leptothrix-like), which again may fall into still shorter rods. Spiral forms are also described as belonging to the genetic cycle of Cladothrix and Beggiatoa. These are formed by the breaking up of a thread which had become spiral in virtue of one-sided growth, and the resulting fragments are *Spirillum*-like or *Spirochate*-like, according to the closeness of the spiral and thickness of the portion of the thread to which the fragment belonged. Whatever their length and shape the fragments formed in the course of this retrogressive development attain cilia on becoming free. It is similarly asserted that all of the *Micrococcus*, *Bacterium*, and *Bacillus*-like forms found in the mouth belong to the genetic cycle of *Leptothrix buccalis*.

A similar inconstancy of physiological peculiarities has also been asserted by recent observers, so that the view that disease-producing

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[1] They are usually measured for convenience sake by micro-millimetres, one of these units being the $\frac{1}{1000}$ mm. = $\frac{1}{25000}$ inch, and represented by the sign μ.

Schizophytes are merely varieties of harmless forms which have acquired special virulence is defended by many authorities. Dr. H. Buchner, of Munich, has described the conversion by artificial culture of the ordinary *Bacillus* of Hay-Infusion into the virulent *Bacillus* of Anthrax and *vice versa*. Although many careful observers hesitate to recognize the value of his experiments, there can be no doubt that the virulence of the *Bacillus* of Anthrax may be "attenuated" by cultivation under certain conditions. Such attenuated virus has been employed by Pasteur for the protective innoculation of sheep and cattle against Anthrax. Although the results obtained have not been so satisfactory as could be desired, yet the establishment of the principle is a great step in advance in the fighting of the infectious diseases.

The physiological inconstancy of the Schizophytes is likely to prove as great a stumbling block in the way of their classification as their inconstancy of form. It has been proposed, however, to arrange them in three groups: colour-producing (Chromogenic), fermentation-producing (Zymogenic), and disease-producing (Pathogenic) forms.

To the Chromogenic forms belong the Micrococcus prodigiosus, which forms a red incrustation on bread, besides other Micrococci which produce the characteristic colours of "blue milk," "blue pus," "red sweat," &c. Higher members of the Schizophyte group may also be Chromogenic.

A very large number of forms are recognized as Zymogenic. The yeast plant (Saccharomyces) and its allies, although reproducing by budding and not by division, have nevertheless many points in common with the true Schizophytes, and are conveniently considered along with them. Several species of Saccharomyces are known capable of producing the alcoholic fermentation, but the amount of sugar destroyed and alcohol produced appear to be different for the different species. One form, *S. mycoderma,* is so avid of oxygen that if it should be formed in wine, the alcohol undergoes slow combustion, and eventually little but water is left behind. To the Zymogenic group, however, belong many true Schizophytes; such are the ferments of the acetic, lactic, butyric and viscous fermentations, as well as many others to which chemists and biologists are only now turning their attention. So putrefaction is now generally recognized to be a form of fermentation, complex on account of the

complexity of the fermentable bodies on the one hand, and the complexity of the products of fermentation on the other. The common ferment organism of putrefaction is the *Bacterium termo*, with which others are unquestionably associated.

As already indicated, many authorities regard the pathogenic Schizophytes as constant species with constant physiological peculiarities. Naegeli has most ably defended the opposite view, in accordance with which they are at most physiological varieties, and points to the occurrence of new contagious diseases, and the sporadic appearance of already known diseases, as confirmatory of his theory.

Almost all the generic forms of Schizophytes have been recognized in connection with one or other of the diseases of which they are now generally believed to be the cause. Thus Micrococci have been found in small-pox, diptheria, erysipelas, and some forms of blood-poisoning; Bacteria in septicaemia of the pigeon; Bacilli in anthrax, various forms of septicaemia, malaria, tuberculosis and leprosy, and Spirochaete in relapsing fever. The list of diseases is in fact being daily increased (especially by investigation into various diseases of the domestic animals) with which specific pathogenic Schizophytes (or Microbes, as the French investigators term them), are found to be constantly associated.

Since the establishment of the Germ-Theory of Disease on the sound basis on which it now stands, increased interest has been evinced in the microscopic examination of air and water, the chief media from which the disease germs invade the body. With regard to the latter microscopic examination cannot yet be regarded as affording proof of the harmlessness or the reverse of water for drinking purposes, although the examination of suspected water has revealed in certain cases (Typhus-Brautlecht) micro-organisms to which disease has been attributed. Chemical examination which speedily reveals contamination by sewage, and therefore a possible source of infection, is as yet to be more depended upon. No doubt the researches on the Schizophytes which are now being carried on may tend to render the microscopic analysis of water of greater importance than it is at present. Michel and Hansen's observations with regard to the occurrence of micro-organisms in the atmosphere are of the highest interest. By far the greater number of the spores found floating in the atmosphere belong to moulds, and are therefore quite harmless to man. The same is probably true of the great

majority of the spores of Schizophytes which are also found. Michel has calculated that in the neighbourhood of the observatory at Montsouris a man may inspire in 24 hours 300,000 mould spores and 2,500 Schizophytes. Probably not $\frac{1}{10}$th of these are possessed of any life or capacity for further development, but Michel has nevertheless discovered that the curve representing the occurrence of Schizophytes in the atmosphere, and the curve representing the prevalence of infectious diseases, are coincident. He has shown the necessity for ventilation by pointing out the great increase of microbes in the atmosphere of the Parisian hospitals during winter, when doors and windows are kept close for warmth's sake. He has also shown that microbes are not more abundant in the neighbourhood of open sewers than in the air generally, a fact which is confirmed by investigations of Hansen and Naegeli. The latter demonstrates that all micro-organisms must be previously dried before being carried into the atmosphere. They exist there generally in the spore-condition, a condition which usually steps in when changes unfavourable to the ordinary method of propagation by division have come into operation. The spores, which are produced in the interior of the cells of the Schizophytes, are possessed of much greater vitality than the mother-plants, being able to resist extremes of temperature, and deprivation of moisture and food immeasurably better than these. The discovery of such spores and their properties has given a death-blow to the doctrine of spontaneous generation, for it is now satisfactorily determined that any organic infusion may be kept perfectly free from micro-organisms in a sealed flask, if the proper precautions have been taken not only to kill the mature Schizophyte in it, but also their spores.

It is not surprising in view of these facts that the strength of the disinfectants used to kill septic material must be very different according as the material is in a vegetating or spore-condition. In the latter case no volatile antiseptics, except chlorine and bromine, have been found to possess any efficacy, and it has been shown that the antiseptic virtues of carbolic, salicylie, &c., have been greatly overestimated. As a result of various experiments made to determine the best means of disinfecting clothes (rags impregnated with spores of *Bacillus anthracis* being chiefly employed), prolonged boiling—for several hours—has been recognized as the simplest efficacious method. The experiments have shown that the process of

disinfection of rooms, clothes, &c., during and after contagious disease ought to be under the control of a health officer, in order that this, the most important method of combating the spread of contagious diseases, should be efficiently and systematically carried out.

The introduction of an abundant supply of pure water, and the construction of proper drainage systems, are now aimed at by most large cities: in many the compulsory use of these by all the inhabitants remains to be carried out. So much knowledge has been acquired as to the origin of disease in course of the researches alluded to in the previous pages, that it becomes the obvious duty of educators to extend and provide for the increase of that knowledge. This can be most efficiently done by giving every medical student an opportunity of becoming practically acquainted with the methods of research which have been adopted in the enquiries referred to. It is obvious that medical men in practice will rarely combine leisure, inclination and capacity for such studies; but, on the other hand, much hard work has been expended with little or no result, simply from a want of rigid early training. Such is particularly necessary in the study of these lowest organisms, where errors of observation and experiment are avoided with the greatest difficulty.

CANADIAN INSTITUTE.

ANNUAL REPORT—SESSION 1882–83.

The Council of the Canadian Institute in presenting their Thirty-Fourth Annual Report, are pleased to be able to congratulate the members upon the termination of another successful year.

They are particularly gratified with the character of the communications which have been read at the meetings, and point with pleasure to the fact that some of the more important of them are the work of quite young men, from whom many additional valuable original investigations may be expected in the future. Another promising feature of the history of the Session that has just closed is the great increase in the number of members, which has risen from 139 to 225. The Council also have pleasure in reporting an increase in the average attendance at the Saturday evening meetings.

During the month of September a course of popular lectures on Sound was delivered in the Library Hall, under the auspices of the Institute, by Professor Loudon, of University College in this city, and Dr. Kœnig, of Paris. Another course, consisting of four lectures. including one by each of the following members, namely, President Wilson, Dr. Reeve, Professor Wright, and Mr. Lauder, was delivered in January and February, under the management of a Committee of the Council. The Council recall with pleasure the share they had in furnishing the public with an opportunity of hearing these exceedingly instructive and valuable lectures.

Early in the Session the Council deemed it advisable to adopt a resolution, providing that the Library and Reading Room should be kept open seven hours on Saturdays and five hours on other week days. This led to the resignation of the Assistant Secretary, Mr. Thomas Heys, to whose long and valuable services the Council gladly seize this opportunity of bearing testimony. He has been replaced by Mr. R. W. Young.

Though a considerable sum of money has been spent in furnishing the Library Hall with gas fixtures and seats, and in increasing the number of the periodicals taken for the Reading Room, the Council are gratified to find that the report of the Treasurer shows that the financial position of the Institute has not been weakened.

A large amount of work has been done during the year by members of the Council, and under their direction, with the view of putting in order and cataloguing the library, and preparing for binding the very considerable collection of transactions of scientific societies and other publications of value which we have in our possession. The binding has not actually been done, as

it was thought best, before proceeding with it, to make exertions to complete imperfect sets and replace missing numbers, but the Council recommend the matter to the early attention of their successors. They also suggest the desirability of taking further steps, as soon as practicable, to put our scientific collections in complete order.

Appended to this report are abstracts showing: (1) The present condition of the membership; (2) the papers communicated at the meetings during the year; (3) the additions to the library and the donations during the same period; (4) the Treasurer's balance sheet; (5) the Lecture Committee's balance sheet.

All of which is respectfully submitted.

J. M. BUCHAN, *President.*

MEMBERSHIP.

Members at commencement of Session, 1882-83	139
Members elected during the Session	117
	256
Withdrawals and deaths	31
Total Membership, March, 1883	225
Composed of:	
Corresponding Member	1
Honorary Member	1
Life Members	17
Ordinary Members	206
	225

LECTURE COMMITTEE.

By Season and Single Tickets	$129 25
To Honorarium to Lecturers, Advertising, &c.	122 50
	$6 75

SUMMARY OF FINANCIAL STATEMENT FOR THE YEAR 1882-83.

I herewith submit my financial summary of accounts for the year of 1882-83.

The Annual Subscriptions are more than usual by reason of increased membership. Two Government Grants have occurred and been received during the financial year, and rent receipts have been more than usual. The interest payment has been reduced, while the only items of increased expenditure worthy of notice are those of fuel, furniture and gas fixtures, the last two of

which are not likely to occur again. The Institute may well be congratulated upon its healthy condition, and its substantial balance now in the Bank and at its credit.

To Annual Subscriptions	$509 00
" Subscriptions to Building Fund	21 00
" Government Grants	1,500 00
" Rent from Warehouse	60 00
" Rent from Toronto Medical Society	50 00
" Rent from Elocution Society	25 00
" Rent from Catholic Literary and Debating Society	18 75
" Rent from Natural History Society	7 50
" Rent from J. Buchan for use of Hall	5 00
" Journals sold during the year	2 25
	$2,198 50

By Due to Treasurer from last Audit	$133 75
" Interest	238 78
" Salary	335 33
" Fuel	117 90
" Gas fixtures	146 34
" Furniture	115 00
" Printing	80 70
" Advertising	75 00
" Periodicals	69 75
" Painting	31 60
" Postage	48 87
" Carpenter work	27 57
" Gas supply	24 34
" Water supply	18 00
" Express charges	11 95
" Taxes	9 51
" Contingencies	25 07
" Balance in Bank	689 04
	$2,198 50

JOHN NOTMAN, *Treasurer.*

Examined, compared with vouchers, and found correct.

E. A. MEREDITH, }
J. GALBRAITH, } *Auditors.*

28th April, 1883.

LECTURES AND PAPERS.

On Sound: By Dr. Kœnig, Paris, France, and Prof. Loudon, University College, Toronto.

1.—Mechanism of the Ear: Noises, Notes and Tones. (Sept. 15th, 1882.)

2.—Qualities of Sounds: Pitch, Intensity and Timbre. (Sept. 18th, 1882.)

3.—Methods of Studying Vibrations: Determination of Pitch. (Sept. 20th, 1882.)

4.—Determination of Intervals: Scales, Propagation of Sound, Communication of Vibrations, Composition of Vibrations. (Sept 22nd, 1882.)

5.—Phœnomena produced by the Co-existence of Two Sounds: Interference, Beats, Sounds of Beats. (Sept. 25th, 1882.)

6.—Timbre of Sound: Analysis and Synthesis. (Sept. 27th, 1882.)

Reindeer and Mammoth Age of Southern Europe. (Dr. Daniel Wilson, President of the University of Toronto, January 19th, 1883.)

The Hygiene of the Eye. (Dr. Reeve, January 19th, 1883.)

The Germ-Theory of Disease. (Prof. Ramsay Wright, University College, Toronto, January 26th, 1883.)

Richard Wagner and the Music of the Future. (Prof. W. Waugh Lauder, February 2nd, 1883.)

Science and Progress. (The President's Inaugural Address, November 4th, 1882.)

Some Laws of Phonetic Change in the Khitan Languages. (Prof. Campbell, of Montreal; read for him by Prof. Loudon, November 11th, 1882.)

The Presence of Tellurium, in connection with Gold, Silver and Lead, in Specimens of Ore from Lake Superior. (Prof. Ellis, School of Practical Science, Toronto, November 11th, 1882.)

Anthropological Discoveries in Canada. (C. A. Hirschfelder, Esq., November 18th, 1882.)

The Transit of Venus. (Mr. Carpmael, Superintendent Toronto Observatory, November 25th, 1882.)

The Classification of Languages. (Mr. W. H. Vander Smissen, December 2nd, 1882.)

The Ophidians of Texas. (Prof. Croft: read for him by Dr. J. E. White, December 9th, 1882.)

Description of an Interesting Historical Monument of the 15th Century. (Dr. Daniel Wilson, President of the University of Toronto, December 16th, 1882.)

A Demodex in the Skin of a Pig. (Prof. Ramsay Wright, University College, Toronto, December 16th, 1882.)

Description of a New Micro-photo-graphic Apparatus, and a Résumè of Cohn's Experiments on Trichinæ. (Prof. Ramsay Wright, January 20th, 1883.)

Evidence of Water-action on the Surface of the Moon. (Mr. A. Elvins, January 20th, 1883.)

Some Reasons Why so many Persons Die of Consumption, (Dr. P. H. Bryce, January 27th, 1883.)

On Spelling Reform. (Mr. W. Houston, February 3rd, 1883.)

A Topographical Argument in favour of the Early Settlement of the British Isles by Celts whose language was Gaelic. (Rev. Neil McNish, D.D., Cornwall; read for him by Mr. W. H. Vander Smissen, February 10th, 1883.)

On the Water supplied to the City of Toronto. (Prof. Ellis, School of Practical Science, Toronto, February 17th, 1883.)

Some Forms of Canadian Infusoria. (Prof. J. Playfair McMurrich, February 17th, 1883.)

The Poisonous Snakes of North America. (Dr. Garnier, Lucknow, February 23rd, 1883.)

The Principles of the Solutions of Equations of the higher Degrees. (Prof. Young, University College, March 3rd, 1883.)

On the Analysis of Tea. (Prof. Ellis, March 3rd, 1883.)

On Lord Durham's Report, 1839. (Mr. William Creelman, March 10th, 1883.)

On Nomenclature. (John Notman, Esq., March 17th, 1883.)

On Some Experiments on Ice. (W. J. Loudon, B.A., March 24th, 1883.)

On Pendulum Curves. (W. J. Loudon, B.A., March 24th, 1883.)

The Practical and Theoretical Study of Archæology. (C. A. Hirschfelder, Esq., March 31st, 1883.)

On the Microscopic Organisms found in Toronto Tap-water. Messrs. Acheson and McKenzie, April 7th, 1883.)

A Chemical Analysis of the Toronto Water Supply. (Prof. Ellis, April 7th, 1883.)

The Hymenoptera of Ontario. (Mr. William Brodie, April 14th, 1883.)

What is Wealth? (W. A. Douglas, Esq., April 21st, 1883.)

Some new Emendations in the Text of Shakespeare. (E. A. Meredith, Esq., LL.D., April 21st, 1883.)

On Colonies for Invalid School Children. (Dr. Covernton, April 28th, 1883.)

On the Discovery of the Pelly River. (J. H. Hunter, Esq., M.A., May 5th, 1883.)

On the Prairie Chicken. (Ernest E. T. Seton, May 5th, 1883.)

ADDITIONS TO THE LIBRARY OF THE CANADIAN INSTITUTE.

Received from April 1st, 1882, to March 31st, 1883.

I.—DONATIONS.

Le Figaro et Supplement, Paris. Presented by G. E. Shaw, Esq., M.A.

Le Temps, Paris. Presented by Dr. C. W. Covernton.

The Spectator, London. Presented by Prof. Hutton, University College.

Das Echo, Berlin. Presented by W. H. Vander Smissen, M.A., University College.

The Historye of the Bermudas, edited from a MS. in the Sloane Collection, by General Sir J. H. Lefroy, R.A., C.B. Presented by the Editor.

Obstetric Table, by G. Spratt. 3rd Ed., 2 Vols. Presented by Dr. T. Cowdry.

The Financial Reform Almanac for 1883. Presented by the Cobden Club.

On the Results of Recent Explorations of Erect Trees, containing Animal Remains in the Coal Formation of Nova Scotia, by J. W. Dawson, LL.D., F.R.S. Presented by the Author.

First Annual Report of the Bureau of Ethnology for 1879-80. Presented by the Director, J. W. Powell, Esq.

Documents Relating to the Colonial History of the State of New York. Vol. 2. New Series. Presented by the Trustees of the New York State Library.

The Century Magazine for March, 1882. Presented by James Bain, jun., Esq.

Papers on "Canadian Fresh Water Polyzoa," "Parasites in the Pork Supply of Montreal," and "Certain Parasites in the Blood of the Frog," by William Osler, Esq., M.D. Presented by the Author.

Paper on the Origin of the so-called "Test Cells," in the Ascidian Oran, by J. Playfair McMurrich, B.A. Presented by the Author.

II.—EXCHANGES.

CANADA :

The Statutes of Ontario for 1882.

The Canadian Entomologist, Nos. 5-12, 1882, and Nos. 1-3, 1883.

Transactions of the Ottawa Field Naturalists' Club, No. 3, and Circular.

The Canadian Naturalist, Vol. X., Nos. 2, 3, 4, 5, 7.

Bulletin of the Natural History Society of New Brunswick, Nos. 1 and 2.

Discovery of Tripoli, near St. John. Pamphlet.

Annual Report of the Natural History of New Brunswick.

Medicinal Plants of New Brunswick.

Transactions of the Literary and Historical Society of Quebec, 1881-82.

The Canadian Practitioner and Canadian Journal of Medical Science to March, 1883.

Publications of the Manitoba Historical and Scientific Society, Winnipeg, Nos. 1-4.

Transactions, No. 3.

Annual Report, 1882-83.

The Monthly Weather Review of the Meteorological Service, Dominion of Canada, April, 1882, to March, 1883.

General Meteorological Register for the year 1882.

The Weekly Health Bulletin, issued by the Board of Health of Ontario.

First Annual Report of the Provincial Board of Health of Ontario for 1882.

UNITED STATES OF AMERICA :

Transactions of the New York Academy of Sciences, 1882-83.

Annals of the New York Academy of Sciences, 1882.

Memoirs of the Boston Society of Natural History, 1882.

Proceedings of the Boston Society of Natural History, 1882.

Bulletin of the Essex Institute, Salem, 1881.

Flora of Essex Co., Mass., by J. Robinson, 1880.

The Penn Monthly, New York, June, 1882.

Publications of the Missouri Historical Society, Nos. 5-7, 1881-83.

Proceedings of the Academy of Sciences, Philadelphia, 1882.

The Pennsylvania Magazine of History and Biography, Nos. 21–23, 1882.

Annual Report of the Peabody Institute, Baltimore, 1882.

Smithsonian Report, 1880.

Bulletin of the Minnesota Academy of Natural Sciences, Vol. 2, No. 2. Proceedings, 1881.

Annual Report of Yale Observatory, 1881–82.

Bulletin of the Museum of Comparative Zoology, Harvard College, Vol. X., Nos. 1–4.

Annual Report of the Curator of the Museum of Comparative Zoology, at Harvard College, for 1881–82.

Worcester Town Records, 1882.

Proceedings of the American Antiquarian Society, Vol. 2, Parts 1 and 2. 1882.

Proceedings of the Davenport Academy of Natural Sciences, Vol. III., Part 2, 1882.

The Journal of Speculative Philosophy, Vol. XVI., Nos. 1 to 4, 1882.

Scientific Proceedings of the Ohio Mechanics' Institute, Vol. 1, No. 4; Vol. 2, No. 1, 1882–83.

Annual Address of the President before the Bridgeport Scientific Society, 1882.

Bulletin of the Buffalo Society of Natural Sciences, Vol. IV., No. 3, 1882.

Thirty-first Annual Report of the New York State Museum of Natural History, by the Requests of the University of the State of New York.

Sixty-second, Sixty-third and Sixty-fourth Annual Reports of the Trustees of the New York State Library for the years 1880 and 1881.

MEXICO:

Anales del Museo Nacional de Mexico, Iomo 2 and 3, 1882–83.

ENGLAND:

Proceedings of the Royal Geographical Society, 1882–83.

Transactions of the Royal Geographical Society, July, 1882.

Journal of the Anthropological Institute of Great Britain and Ireland, Vol. 11, No. 4; Vol. 12, Nos. 1–3.

The Journal of the Transactions of the Victoria Institute, March, 1882, No. 61, No. 62, and November, 1882.

Journal of the Royal Microscopical Society, Nos. 27 to 32.

Minutes and Proceedings of the Institute of Civil Engineers, Vols. 58, 59, Part 3, 67, 70.

Journal of the Linnean Society, Zoology, Vol. 13, No. 72, 1878; Vol. 14, Nos. 73–80, 1877–79; Vol. 15, Nos. 81–88, 1880–81; Vol. 16, Nos. 89–94, 1881–82.

Journal of the Linnean Society, Botany, Vol. 16, Nos. 93–97, 1877–78; Vol. 17, Nos. 98–105, 1878–80; Vol. 18, Nos. 106–113, 1880–81; Vol. 19, Nos. 114–121, 1881–82.

Proceedings of the Linnean Society of London from November, 1875, to June, 1880.

List of the Linnean Society of London for 1877–78; November 1, 1879; January, 1881.

Proceedings of the Literary and Philosophical Society of Liverpool, Vols. 33 and 34.

Proceedings of the Royal Colonial Institute, Vol. 13, 1881–82.

Transactions of the Manchester Geological Society, Vol. 16, Parts 14–18; Vol. 17, Parts 1–4.

Transactions of the Royal Geological Society of Cornwall, Vol. X., Part 3.

Catalogue of the Royal Geological Society of Cornwall, 1882.

Annual Report of the Leeds Philosophical and Literary Society, 1881–82.

Eighth Annual Report of the Public Library and Gallery of Art Committee, 1881–82.

The Scientific Roll, by Alexander Ramsay, F.G.S., Nos. 1–10. 1880–83.

SCOTLAND:

Proceedings of the Society of Antiquaries of Scotland, 3 Vols, 1878–79, 1880, 1881.

Proceedings of the Philosophical Society of Glasgow, 1881–82, Vol. 13, No. 2.

Transactions of the Royal Society of Edinburgh, 1880–81.

Proceedings of the Royal Society of Edinburgh, 1880–81.

Transactions of the Royal Scottish Society of Arts, Vol. X., Part 4.

IRELAND:

Proceedings of the Royal Irish Academy, Vol. 2, No. 3; Vol. 3, Nos. 7 and 8.

Transactions of the Royal Irish Academy, Vol. 28, Nos. 6–10.

Annual Reports, Belfast Natural History Society, 1879–80, 1880, 1881.

Index of Proceedings, Vol. 1, 1873–80.

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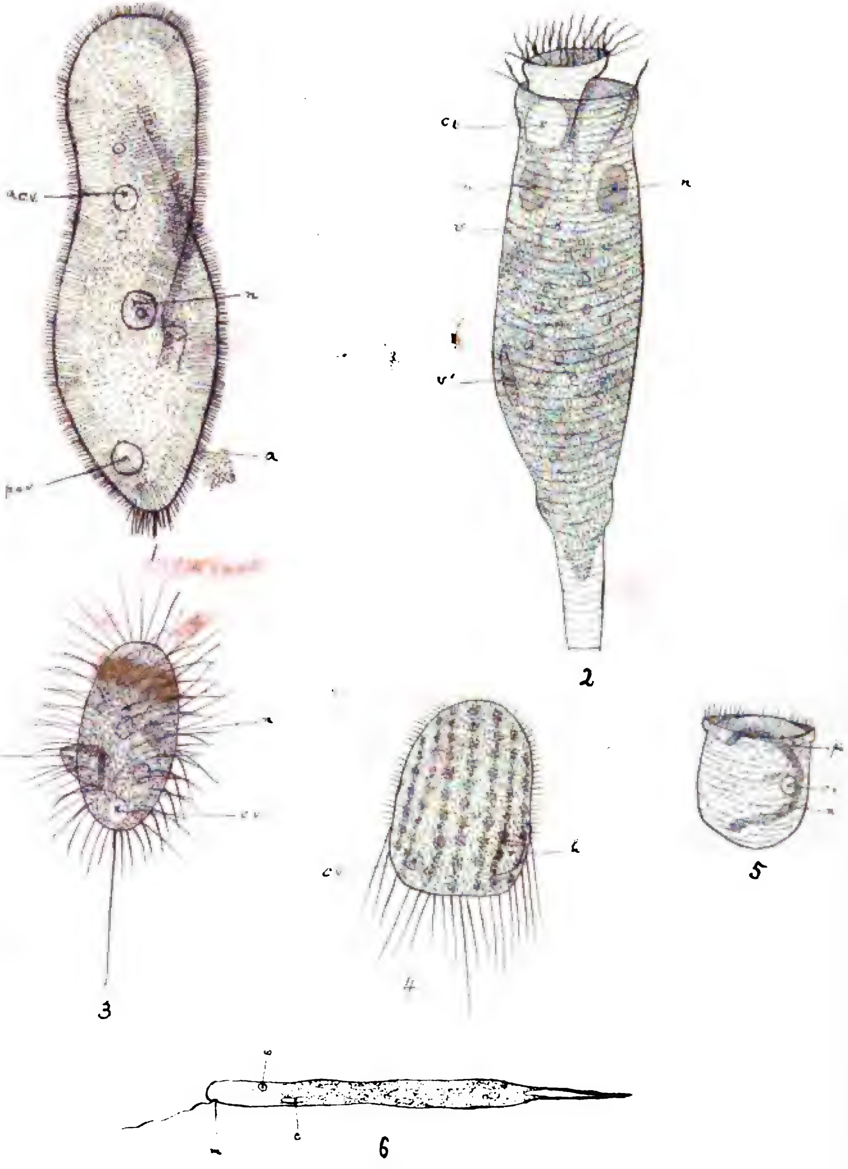

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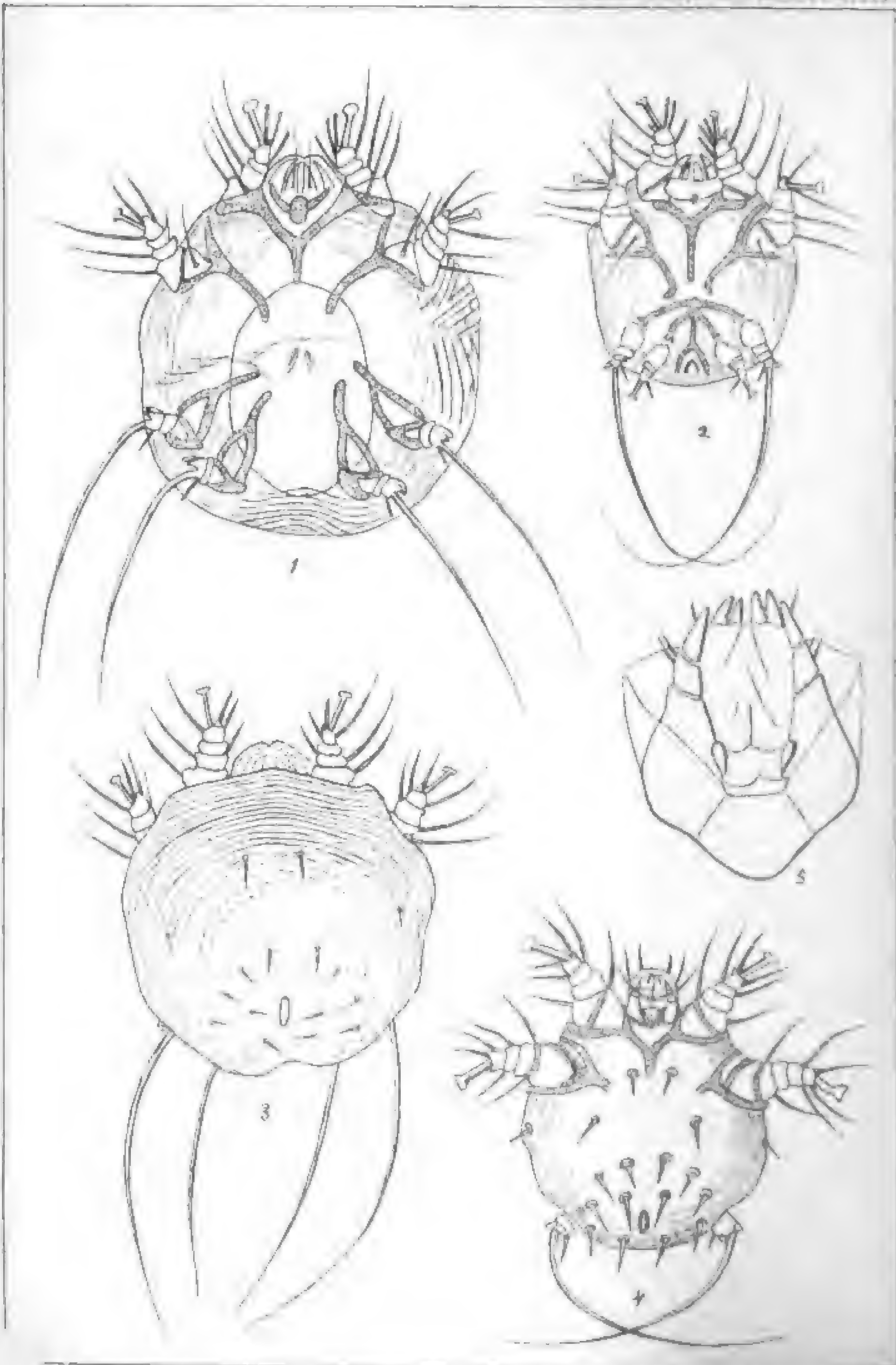

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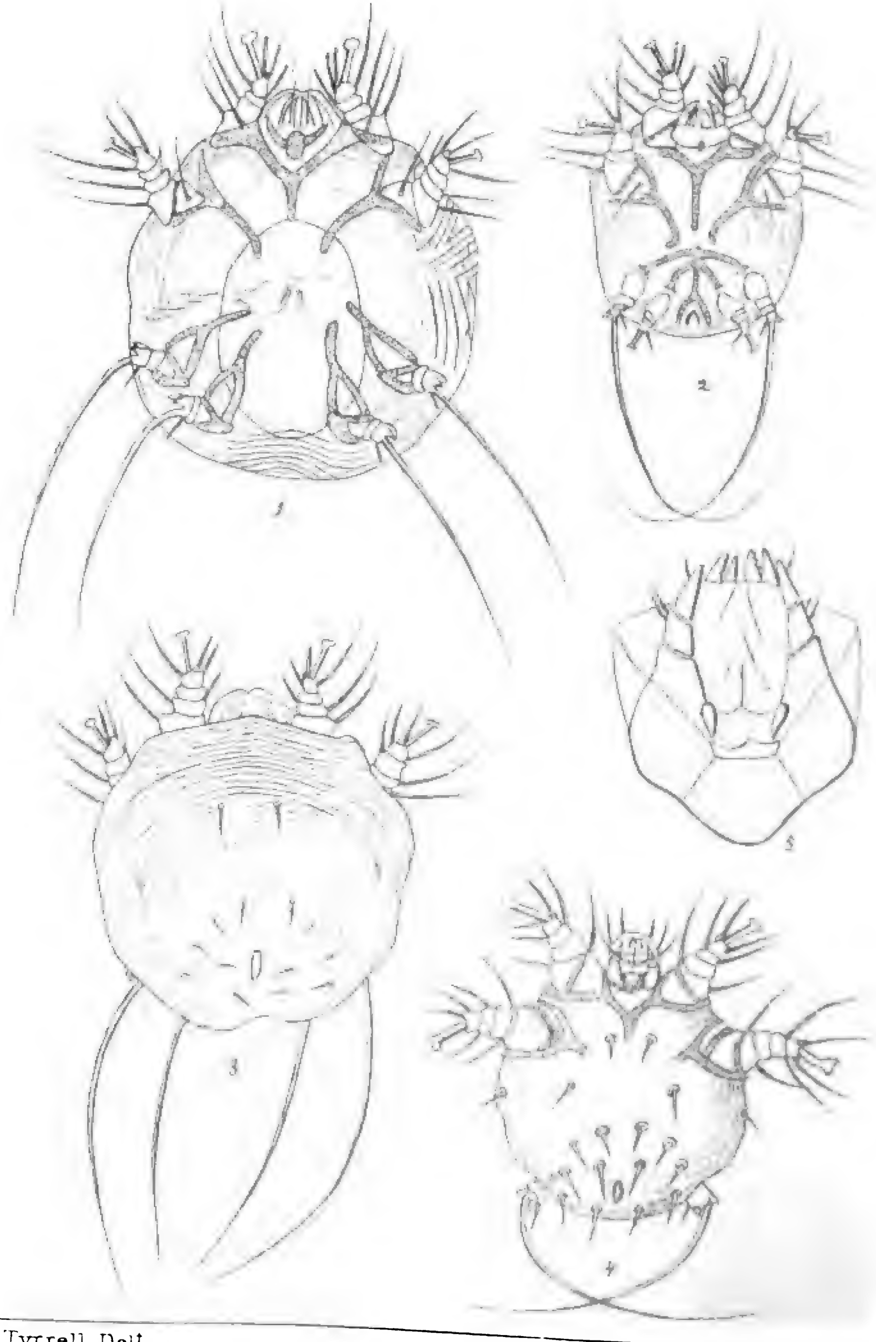

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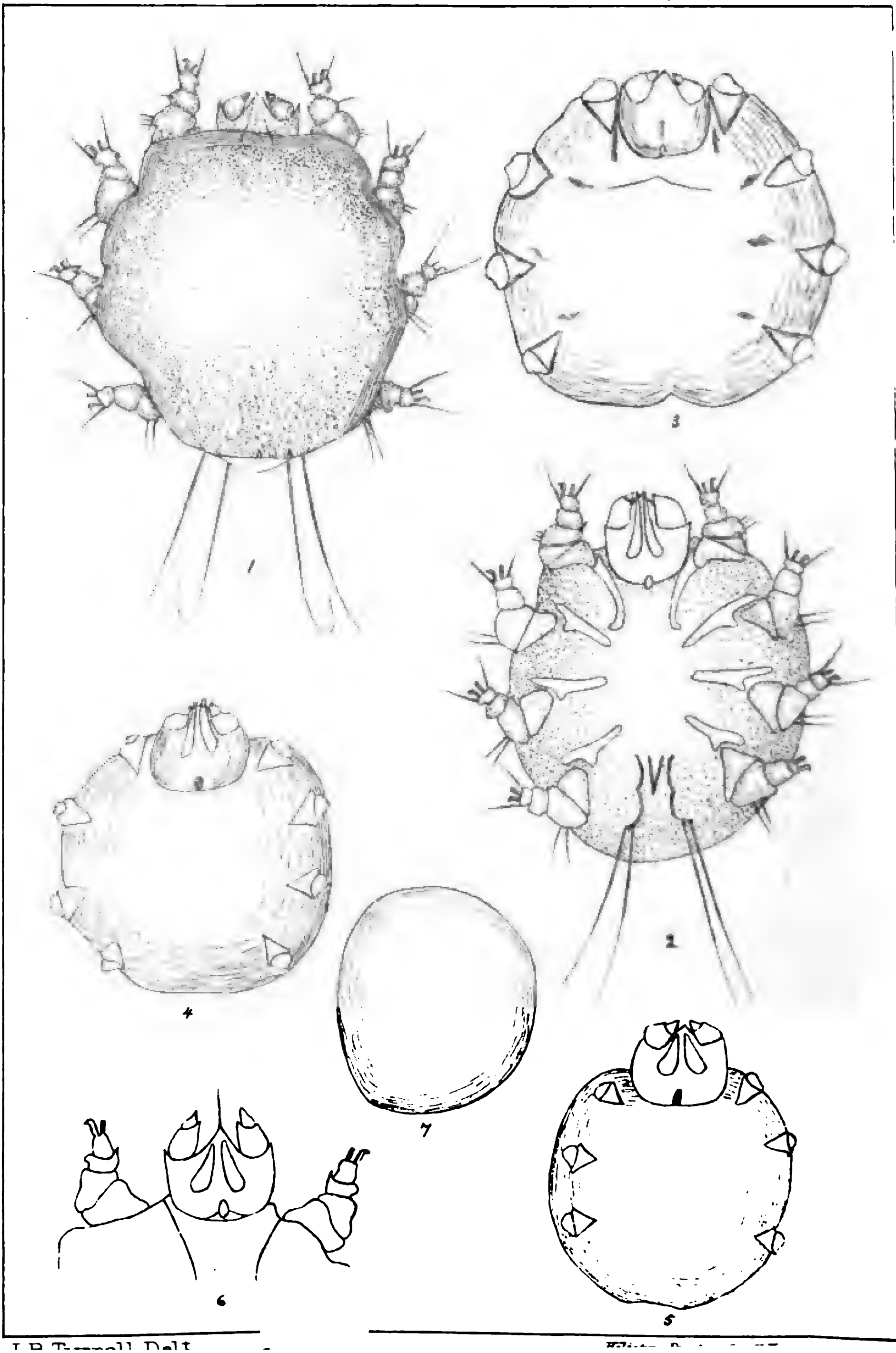

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THE PRESIDENT'S ADDRESS

FOR THE SESSION 1882-3.

BY J. M. BUCHAN, M.A.

[*Read at the Opening Meeting, November 2nd, 1882.*]

Ladies and Gentlemen :

In appearing before you at this, the first meeting of the Canadian Institute during the present season, in order to assist in inaugurating what I trust may be an important and interesting winter's work, I desire in the first place to acknowledge the high honor which my fellow-members have conferred upon me in electing me to the presidency. I regret, indeed, that the duties which that honor imposes have not fallen into abler hands ; but in undertaking to attempt to perform them I rely upon the kind forbearance and active coöperation of all who have at heart the welfare of this old, important and useful institution.

The value of associations of the kind of the Canadian Institute is very often not recognized by the general public. Nor is this to be wondered at. Our work is from its very nature not likely to make much noise or attract much attention. Nevertheless we discharge a function, the importance of which will at once be conceded when it is stated. The Canadian Institute serves as a rallying point for cultivators of all branches of knowledge, for original investigators, and for all who without themselves performing original work, or in any special sense cultivating knowledge, desire to afford every aid and encouragement possible to those that do. Here any one who has in any way enlarged the sphere of our knowledge will find some to appreciate and applaud his efforts. We do not, however, confine ourselves to mere appreciation and applause ; as well as we can, we discuss and criticise ; and every year a certain number of papers are selected for publication in our transactions. These transactions are sent to other similar societies in exchange for their published proceedings, and in this way our and their knowledge of what work is being done is kept up. We correspond in this way with 114 bodies in various parts of the civilized world. You will find on our tables

proceedings and reports from various bodies in the United States of America, Mexico, South America, the British Islands, France, Spain, Italy, Belgium, Holland, Germany, Austria, Denmark, Norway, Sweden, India, Australia, and other countries, giving us information as to what the learned world is doing everywhere in all departments of inquiry. These are of great value to the specialist, inasmuch as they enable him to ascertain what other specialists in his department are doing. We are in this way a member of a great federation of learned societies, each of which, as far as practicable, coöperates with all the rest, and whose work, when summed up, amounts in each year to a great total, however insignificant the contributions of individual bodies may be. The existence of these learned societies is one of the marked features of the history of modern times, and both an index of a great advance in civilization, and an augury of still greater progress.

In addition to encouraging research and the acquisition of knowledge, we undertake to discharge the related function of receiving and caring for objects of scientific, historical or antiquarian interest. We have already accumulated a considerable collection, which we are now engaged in classifying, and we hope ultimately to have here a museum which will be one of the most interesting sights in the city. We have hitherto been prevented from arranging our material by two causes. Before this building was erected we had no room; since its erection we have had no money. We now feel able to attempt to devote a little money every year to this purpose; not as much indeed, as we would like, but still some. I know of no object to which one of our wealthy fellow citizens could better devote a legacy of a few thousand dollars, than to the building up of our museum. And there is a pressing need of a good museum somewhere in Ontario, for one reason. There are scattered over this country an immense number of objects of ethnological and archæological interest, that have recently been obtained from Indian ossuaries which reveal to us the physical character and state of civilization of the aborigines of this country before they came into contact with the white race. Unless some effort is made to prevent it many of the most valuable of these relics will be lost, or destroyed, or carried off to other countries. The Canadian Institute proposes to do what it can to meet this want, and it asks for the hearty coöperation of all who feel the importance of the work.

It is the intention of the Council of the Canadian Institute to arrange for two short courses of public lectures this winter. One of these courses will be scientific, the other literary. What the Council aims at is to perform somewhat the same kind of work as is done by the Royal Institution and some similar societies in London. The Council asks for the cordial assistance of the friends of the Institute in carrying out this scheme, not only on account of the intrinsic desirability of having such courses delivered, but also because it hopes to be able by means of the surplus of receipts over expenses to add to the amount available for improving the museum and library.

I now purpose inviting your attention for a short time to some remarks on the relation between progress in physical science and progress in other departments of thought and action. It is of course impossible for me to do justice to so vast a subject, in the time at my disposal, nor do I flatter myself that I could say very much that is new, if I had time, but I have selected this topic for a few inaugural remarks, because discussion of it, however imperfect, will throw more light on the real importance of societies such as the Canadian Institute than anything else which I could say.

It will in the first place be advisable to obtain a clear idea as to what is meant by the word science. Science originally meant knowledge, but now it means something more. A man may know a great deal about some groups of facts, and yet have no scientific knowledge of them. A savage of three-score-and-ten who has spent his life in hunting will have a great knowledge of animals, but not a scientific knowledge. An accumulation of knowledge becomes a science when it is brought into order by the discovery of great general statements that enable us to arrange the facts, or by the discovery of the laws of certain phenomena. The savage whom I have just mentioned would come to have a scientific knowledge of zoology, if he became able to arrange the animals he knew in certain classes. In proportion as knowledge becomes systematized it becomes science.

In the next place what is meant by physical as distinguished from other science? The physical sciences are those which deal with the material universe; mental and moral science deal with the spiritual universe. The term natural science is now often used as synonymous with physical science. Originally it meant something quite different

and might have been construed to include much that is now brought under the head of mental and moral science. It meant all science that is not supernatural, that is, all knowledge that is not obtained by revelation from the Deity or by occult dealings with the devil and his agents. It is used in this sense in the charter incorporating the Royal Society granted about the beginning of Charles II.'s reign. The reason of the change in the meaning of the term is to be found in the fact that since that date the progress of physical science has been much greater than that of mental or moral science. In the same way and for the same reason the generic term, science, has come to be commonly used in the specific sense of physical science. There is a latent popular disbelief in the existence of any science except physical science.

There is no race of mankind since history began that is not, and has not been, in possession of some of the facts on which the various physical sciences are based. But progress in physical science depends not so much on capacity for collecting facts as on ability to discover the laws of facts, and this ability has never been manifested to any considerable extent except during the last three centuries and a half, and then only in the limited part of the earth's surface occupied by the civilized European nations. The ancient Greeks, indeed, whose vigour of intellect led them to attempt every department of inquiry, paid great attention to the physical sciences, but their progress was not at all commensurate with the amount of effort they put forth. We have accounts which show that they laid siege to the secrets of nature for about 800 years, or from the time of Thales, about 600 years before, to that of Ptolemy, the astronomer, about 200 years after Christ; but during all this time they did not succeed in establishing one important physical law. It is true that some Greek astronomers broached the idea that the earth is round, and the sun the centre of the system of worlds to which the earth belongs; but not only were these views not established, the contrary notions prevailed. The Ptolemaic system, which obtained universal acceptance until the 16th century, made the sun revolve around the earth. Archimedes, indeed, discovered the laws of the equilibrium of fluids, but he did not succeed in so establishing them as to make them a part of the common mental property of mankind.

The failure of the Hellenic intellect in this department appears to have been due to the adoption of a wrong method. In modern times

great progress has been made because the scientific mind has become impressed with the necessity of, from time to time, examining every received theory, in order to ascertain whether it is still in accordance with facts. Thus, the phlogistic theory of chemistry promulgated by Stahl and Beccher was replaced by the oxygen theory of Lavoisier, when the discoveries of Scheele, Priestley, Cavendish and Black, showed it to be no longer tenable; and in our own day a very considerable change in chemical theory and nomenclature has been made, because the facts were found not to agree with deductions from the received theory. Now, the Greeks did not neglect to observe facts, and in truth, all the theories that they formed were based on facts. But they had, as Buckle thinks the Scotch have, a strong bias towards deduction, and having once made a generalization, their tendency was to reason from it and accept the results of this reasoning without ascertaining whether they too were supported by the facts. From this, also, resulted a great indistinctness and haziness in their explanations of phenomena, even when they had by chance obtained some glimmering of the correct view. As in the case of the giant who received an accession of strength when he touched mother earth, it is for the advantage of all theorizers to come down frequently to the solid basis of reality. This tendency to deduction in the Greek mind had, indeed, its good side. To it we owe the geometry of Euclid, which is the logical exhibition of the conclusions implicitly contained in a few definitions, postulates, and axioms. In modern times there has been a close alliance between the mathematicians and the devotees of the sciences of observation and experiment, to their great mutual advantage. But whatever may have been the cause, the geometry of Euclid failed in ancient times specially to promote progress in other sciences.

While the failure of the Greeks to make any great advance in this department has its lesson for us, the fact that they were the only race of antiquity that made great and persistent exertions to solve scientific problems has also its lesson. What was the cause of the great intellectual activity of this race? I believe it to have been due to the same causes that made the Greeks free, whether these were climatic, or racial, or connected with their occupation and mode of life. As compared with Rome or Carthage, Athens and some of the other great commercial cities of Greece were decidedly democratic, the Roman and Carthaginian populations having never been able to

shake off the influence of great leading families to the extent to which this was done in some parts of Greece. Rome was, however, freer than Carthage, and accordingly we find that, while in Carthage there was little intellectual activity, apart from trade, in Rome there was some, and in Athens a great deal.

The most interesting part of history is that which throws light upon the ideas and influences that have borne sway over the minds of men. If we could gain a complete knowledge of these, we should easily be able to construct a philosophy of history, for the great movements of every age are due to these springs. The deed always exists in thought before it becomes fact; and, though it would not be correct to say that humanity is conscious of the influences that sway it at any particular time, yet it is true that the historical facts of the next generation have now an immaterial, but no less real existence, in the tendencies of the modes of thinking, feeling, and acting of the present. Buckle has said that Shakspere helped much to make Newton. I think that true, and I think that Newton has in his turn exercised an influence on literature. To Newton, had he been born earlier, both the antecedent discoveries necessary to enable him to perform the work that he did, and the stimulus to do this work, would have been alike wanting. There were undoubtedly very many men of great ability in the middle ages; but not one of them in any way materially advanced physical science during that period of a thousand or more years.

There was, in fact, other work to be done in those times. Out of the disorganization resulting from the break-up of the Western Roman Empire, a new polity was to be developed. New common interests were to be created to bind together the various races and to override the differences which separated them. The history of Western Europe has since that time been increasingly one. In every period since then, and now more than ever, every important internal change in one of the civilized European states is found to affect the rest. In the middle ages, indeed, all Western and Central Europe tended, more and more, to become, and finally became one community, at the head of which was the Pope; and, though his religious headship has long since ceased to be recognized by some of the states, and Russia has forced her way into the circle, there is still a real oneness of civilization and interests. This oneness comes out in a remarkable manner when we consider the general movement of events in modern times, and this it

will be necessary briefly to do in order to show the part which has been played by physical science.

During the middle ages the church was in the van of human progress. She bound together distant lands by the tie of a common belief, a common religious language, a common priesthood, and common prayers. Under her influence all Latin Christians came more or less to feel that they were brethren. Before all the nations of the rude west was placed a lofty ideal of life; and into all were introduced under her auspices some seeds of useful knowledge, of art, of learning, and of refinement. The monks improved agriculture in the north and west; every pilgrim that went to Rome brought back new ideas; and the clergy were the conservers and disseminators of the little knowledge of the time. But perhaps the most important work that the church did in those ages was that which she performed in aid of the abolition of serfdom. For lending her powerful assistance to the cause of personal liberty she deserves the everlasting gratitude of mankind.

With the abolition of villenage the church ceased to lead. Personal freedom led to increased industry, towns sprang up all over Europe, there was a great development of commerce, and wealth increased. Increase of wealth led to a greater diffusion and increase of knowledge; this in its turn led to inventions and discoveries; gunpowder revolutionized war; the printing press multiplied books; the Renascence, or new birth of learning, art, and literature, follows; then comes Luther, and personal freedom has led to a movement for spiritual emancipation.

The revolt of Luther was contemporary with a great outburst of imprisoned forces and a great onward movement of humanity. Before the middle of the seventeenth century four great national literatures had come into being, the English, the French, the Spanish, and the Italian. The northern part of Europe became religiously independent, and this religious independence was conjoined in two cases, England and Holland, with political freedom. The air was full of bold and original speculations, and nature began for the first time in the history of man to find herself interrogated with success. The first great event in the history of science is the establishment of the heliocentric theory by Copernicus. Copernicus was a contemporary of Luther, dying just three years before him, and, though he lived and died in the old faith, was, in his own way,

as much as Luther in his, the leader of a revolt against authority. Though he seems to have satisfied himself of the truth of his views early in the century, he did not promulgate them till about 1540. They made their way slowly: it was not until after the middle of the seventeenth century that they were generally received in England. Bacon, the great apostle of induction, never assented to them, and Milton, writing about 1660, bases the machinery of Paradise Lost on suppositions inconsistent with the Copernican theory.

The discoveries of Copernicus were followed by those of Kepler, who established the following propositions regarding the solar system, namely:—

(1) That the orbits of the planets are elliptical.

(2) That the line connecting the sun and any planet sweeps over equal areas in equal times.

(3) That the squares of the periodic times of the planets are in the same proportion as the cubes of their mean distances from the sun. Then follow the discoveries of Galileo, and in the latter half of the seventeenth century Newton appears on the scene to furnish a mathematical explanation of the motions of the heavenly bodies.

About 1581 the laws of the equilibrium of fluids, which had been known to Archimedes, were rediscovered by Stevinus. In 1616 Harvey discovered the circulation of the blood. About 1621 Willebrod Snell discovered that the ratio of the sines of the angles of the incidence and refraction of a ray of light is constant for the same media. During the first half of the seventeenth century the three fundamental laws of motion were established, the most prominent name connected with them being that of a scientific man already mentioned, the astronomer and physicist, Galileo. During the same period Torricelli discovered the vacuum which goes by his name, and Pascal proved that the height of a column of liquid in a tube with a vacuum above it depends upon the weight of the column of air balanced by it. About 1650 Boyle established the law that the density of a gas varies as the pressure, and in 1651 Pecquet, a French physician, discovered the motion of the chyle.

By the middle of the seventeenth century the violent perturbations caused by the great movements of the sixteenth century had for the most part ceased. Italy and Spain, having early rejected spiritual liberty, had fallen into decadence. The Thirty Years' War, the last European religious war, had ended in 1648, leaving Germany

exhausted. The defeat of the Fronde and the consequent establishment of a paternal despotism in France, injuriously affected science in that country. With the decline of interest in religious questions a change came over the intellectual temper of Europe. Though, in the north-west of the continent, knowledge was becoming every year more widely diffused, and the spirit of investigation and discovery was very active, there was throughout the entire civilized world during the period between 1650 and 1750 as compared with the periods preceding and following it an absence of lofty dominating impulses.

It is a noteworthy fact that during this period the greatest intellectual activity was manifested in the country which made the greatest political progress, and that the single scientific name of the highest rank, that of Newton, belongs to the same country.

The Royal Society was one of the results of the same intellectual ferment which produced in the political sphere the civil war and the changes in the English constitution which resulted from it, in the religious sphere the first great English sceptics and the break-up of the national church into sects, and in the literary sphere the poetry of Milton. Its inception dates back to 1645, the last year of the civil war, but it was not organized as the Royal Society until the Restoration. It was one of the marks of the beginning of a new age in England—of an age which, accepting as final the solutions of religious and political questions resulting primarily from the civil war, but thrown into their ultimate shape by the revolution of 1688, devoted itself with a single eye to material progress. For about a century, or from about 1660 to 1760, England was almost destitute of enthusiasms affecting great masses of people. The most typical part of this period is the administration of Walpole. An examination of its character reveals to us a slumbering church and a politically apathetic people governed by a corrupt parliament. Manufactures are increasing, the colonies are growing, foreign trade is developing, waste lands are being reclaimed, population is advancing. Everywhere the evidences of a smug material prosperity are to be discovered. It was a prosaic age. It was likewise, in the most literal sense, an age of prose. Between Milton and Wordsworth we had no poetical writer of the first order of merit. More than this, our modern English prose style was then formed. The long, involved, highly eloquent, but strangely worded, and strangely arranged sen-

tences of Milton sound almost foreign to our ears. The new prose style began with Dryden, was improved by the writers of the age of Anne, and perfected by Dr. Johnson. The thorough limpidity of which the new style is capable is, I believe, to a large extent due to the absence of enthusiasms, to the material aims, and to the mainly matter-of-fact scientific discussions of the age in which it was formed. For it was not an age of brilliant scientific speculations, but rather one in which the mines discovered by preceding geniuses were worked, in which facts were collected, in short an age of considerable though not specially brilliant advances upon the past and anticipations of the future.

The character of this period between 1660 and 1760 is the same throughout Western Europe as in England. It is the plain between two mountain ranges, the pause between two pulsations of hnman progress. It was a period of intellectual ebb. There were undoubtedly great and active minds in all the cultivated European nations; but the work which they performed consisted mainly in extending the application of the laws discovered by the men of the previous epoch and in accumulating new facts. But, though it was a period comparatively infertile in new ideas, it would be a mistake to consider it one of retrogression. It was rather a foundation-laying period, rather the period of the slow germination of the concealed grain.

About the middle of the eighteenth century a change came over the intellectual life of Europe. A new race of writers and thinkers, more numerous than, and as active and able as any the world had ever seen, began to propound new views in every department of human enquiry. To the political thinkers of that age we owe the democratic impulse which within about a hundred years produced the American Revolution, the French Revolution, the change of the Spanish American Colonies into republics, the English Reform Bills, the movements of 1848, the freedom of Italy, the unification of Germany, the abolition of slavery, the great host of socialist movements, the establishment of systems of universal education. To the same movement operating in the moral and spiritual sphere, we owe the overthrow of the Jesuits, the weakening of the alliance between church and state everywhere, the emancipation of proscribed religious minorities, such as the Catholics in England and the Protestants in France, the great tendency to scepticism and atheism which has since

prevailed, the great philanthropic movements for the improvement of the treatment of criminals, of the insane, of idiots, of the mute, and of the blind, the attack upon the use of alcoholic beverages, and various other great humanitarian enterprises.

In literature, a new race of poets arose, untrammeled by received traditions as to the form or the subjects of poetry. Germany produced her first and only great poets, Schiller and Goethe; in England the poetical glory of many preceding ages was eclipsed by that which produced Wordsworth, Coleridge, Shelley, Byron and Scott. The modern philosophical method of writing history was developed by Montesquieu, Voltaire, Hume, Robertson and Gibbon. Contemporaneously with all these intellectual and spiritual movements arose a great scientific one. The latter half of the eighteenth century is preëminently an era of the promulgation of great scientific theories and the discovery of great natural laws. In this work the intellect of France, the country which was most powerfully affected by the great upheaval was by far the most prominent. Lavoisier laid the foundation of chemical science by propounding his oxygen theory. To Romé de Lisle, we owe the science of crystallography, to the two Jussieus is due the natural system of classification in botany; in zoology, Cuvier originated the idea of types, and the same thinker may claim the merit of being one of the fathers of the science of geology. To Fourier, another Frenchman, we owe the accepted theory of the conduction, to Prevost that of the radiation of heat. Coulomb, one of the greatest names in electricity and magnetism, and Laplace, perhaps the greatest advancer of mathematical astronomy since Newton, were likewise Frenchmen of this age, and to these may be added a whole host of lesser names.

In English-speaking countries the spirit of scientific research was only less active. The names of Black, Cavendish, Priestley, Erasmus Darwin, Smith the geologist, Franklin, and the first Herschel at once occur to every one. More eminent than any of these are Dalton, the propounder of the atomic theory in chemistry, and Thomas Young, the establisher of the undulatory theory of light, both of whom flourished about the commencement of this century. In Italy, the foundations of galvanism were laid by Galvani; in Germany, we have Werner, the geologist, and Goethe, the poet, whose theories on the morphology of animals and plants, show that his scientific was not greatly inferior to his literary ability. From that time the number

of scientific workers and scientific societies has steadily and rapidly increased, and while the democratic spirit has been making its way in the political, the scientific spirit has been growing increasingly powerful in the intellectual world.

And there are no signs that either the democratic or the scientific impulse that we owe to the eighteenth century has spent its force. The wave of political liberty still rolls onward, and every year adds some remarkable discovery to the list of scientific achievements. Enough has been said to show that there is a certain sympathy between science and liberty. When the intellect of Europe emancipated itself from authority in the sixteenth century, modern science began; when, in the eighteenth century, the era of democracy set in, a host of new sciences came into existence. In ancient times anything of importance done in science was done by the Greeks, one of the two great free nations. Are these coincidences mere accidents, or do they point to a real connexion between science and freedom? If there is a real connexion, can we to any extent define its nature?

The connexion between science and freedom is, of course, a single phase of that between science and human progress. Let us see whether we can discover how science is related to human progress.

In discussing questions of this kind it is of course impossible to separate completely one element in human progress from the rest, and to point out fully what its reactions have been. The utmost that we can do is to discover some links of connexion. We find for example that in the sixteenth century a great scientific and a great religious movement existed together. From their synchronizing we infer that they were both products of the same general causes, whatever these were. Both were clearly of the nature of revolts against established authority, and to both the principle of the right of private judgment was very important. Up to a certain point the cause of science and that of Protestant theology were the same. But it is impossible not to see that they have long since diverged, and that there is now a certain antagonism between them. There can, of course, be no real opposition between religion and science. All truth is one. But at present certain received theological dogmas and scientific generalizations clash, and until the one, or the other, or both are modified, peace cannot be restored. If, for example, the Deity may send rain in answer to prayer, it cannot be

true that " nature is the expression of a definite order with which nothing interferes."

At any rate the great scientific movement of the last 130 years has been attended with a great development of atheism and scepticism and of materialist philosophies. That scepticism, which it is necessary for the succesful student of science to exercise with regard to every supposed discovery, until it is proved beyond a peradventure, has been carried by many into the religious and philosophical spheres in such a way as to lead to these results. The most popular philosophy of the present age on this side of the Atlantic is that of Herbert Spencer. It owes its origin to the speculations of Charles Darwin, and is simply an application of his theory of natural selection to every department of human inquiry. If not in strictness to be called a materialist system, it is so near to being one as to produce all the hardening and narrowing effects of materialism on nearly all those who adopt it.

In so far as the study of physical science assisted in establishing the principle and furthering the practice of the right of private judgment it served the cause not only of religious, but likewise of political freedom. In so far, too, as it substituted for the old idea of a god capriciously ruling the universe, like an oriental sultan, that of a deity guiding it according to fixed laws, it contributed to the setting up of a good model for earthly governments. Perhaps it would be in accordance with fact to go further in the same direction and say that in so far as the advances of physical science have tended to develope the pantheistic idea that God is not a separate entity, but a force pervading the universe, conscious in many living creatures, unconscious elsewhere, it has set before the world a model for democratic government, seeing that in that form the sovereign power is recognized as really diffused through every part of the state. These analogies may seem fanciful, but those who know how the political and religious ideals of a nation react upon each other will not hastily conclude that there is nothing in them.

It will be interesting to note here that the pantheistic view of the universe referred to just now has permeated the writings of some modern republican poets. Shelley, who began with atheism, ended with views which were pantheistic in character, and it is worthy of notice that he was distinguished among the English poets of his age for the interest he took in physical science. One of his contempo-

raries, Keats, laments in a very beautiful passage that the discoveries of science are lessening the mystery of nature.

> There was an awful rainbow once in heaven.
> We know her woof, her texture, she is given
> In the dull catalogue of common things.

Science does not, of course, really diminish mystery; it merely pushes it back. He who possesses a little knowledge is simply the centre of a small circle whose circumference touches the mysterious at every point. Enlarge the circle by increasing knowledge, and a larger circumference affords more points of contact with infinite mystery. Shelley deals with science in a very different fashion from Keats, and has in a few poems, notably in that of *The Cloud*, made his scientific knowledge furnish part of the very web of his fabric. His pantheism appears in expressions such as that in which he represents the sun as saying:

> I am the eye with which the universe
> Beholds itself and konws itself divine.

Emerson, the American poet and philosophical thinker, recently deceased, is remarkably distinguished for the prominence he gives to the poëtical aspects of science. For him likewise the pantheistic view of the universe had great attractions. His poems abound in passages like the following in that entitled Brahma.

> They reckon ill, who leave me out;
>   When me they fly, I am the wings;
> I am the doubter and the doubt:
>   And I the hymn the Brahmin sings.

Or like this in the Song of Nature, in which in answer to the question:

> But he, the man-child glorious,
>   Where tarries he the while?

He makes her say,

> Twice I have moulded an image,
>   And thrice outstretched my hand,
> Made one of day, and one of night,
>   And one of the salt sea-sand.
>
> One in a Judæan manger,
>   And one by Avon stream,
> One over against the mouths of Nile.
>   And one in the Academe.
>
> I moulded Kings and Saviours,
>   And bards o'er kings to rule, etc.

Thus expressing clearly the view that the greatest beings that have been upon earth are products of the force of nature.

The pursuit of knowledge of any kind has a levelling tendency. It was by no accident that the phrase, republic of letters, was coined. In literature there is no king. There are no more democratic bodies than companies of learners, and the capacity to appreciate any given book, puts at least for a time, the peasant on the same platform with the prince. In the department of physical science, in particular, a man's standing depends completely on his merit. It affords a very good example of the carrying out of the democratic maxim:

La carrière onverte aux talens.
The tools to him that can use them.

More than this, the very spirit of investigation fostered by the study of the physical sciences is fatal to respect for any authority based on no real claim. When men of science take to politics they generally show decided democratic leanings. Again, the improvements in industrial processes, the labour-saving inventions, the many contrivances for increasing the control of man over nature which have resulted from the discoveries of men of science, have linked them, in an intimate way, with the masses of mankind. They are in fact the high priests of industrialism, which is always democratic.

And this leads me to remark that the cultivation of the physical sciences has been favourable to democracy in another way. It has resulted in the building up of a great learned class independent of the court, the nobility, and the clergy, and without any class interests or class organization that can be inimical to the well-being of the state. The importance of this has perhaps not been sufficiently noticed, if noticed at all.

It remains now to still further remark upon the influence of the scientific spirit upon literature. It has, indeed, affected every branch of it. I have already said that the modern philosophical method of writing history had its origin in the eighteenth century. Since then, the scientific method has demolished many a false historical fabric, and a beginning has been made in the science of comparative politics.

We have ceased to believe in Romulus and the she-wolf that suckled him; all early Roman history has been re-written; we are doubtful whether there was a Homer; William Tell's splitting of the apple with his arrow has been shown to be a myth. The pervading scepticism of the scientific method has caused almost all statements

with regard to the past to be subjected to a raking cross-fire. Much has been shown to be unworthy of credence, but the separation of the wheat of history from the chaff, as far as it has been accomplished, has been a work of great value.

In the study of languages also the scientific method has been adopted. But perhaps the most remarkable thing to which attention can be directed in this connection is the rise contemporaneously with the scientific and democratic movements of last century of a race of poets manifesting a sympathy with nature in all her moods never exhibited before. It has often been remarked that the feeling for the beautiful and the sublime in the external world is much stronger in modern than in ancient poets. It has often also been remarked that there was a great revival of the love for external nature in the poets who flourished in England at the end of the eighteenth and the beginning of the nineteenth century. Ruskin, for example, has noticed that the sense of colour is more highly developed in modern than in ancient writers, and in speaking of Scott, he directs attention to the way in which he looks at nature "as having an animation and pathos of its own wholly irrespective of human presence or passion."

It has, I believe, never before been suggested that this is connected with the great development of the sciences of observation. Yet there is some reason for thinking that it is. I must not, however, be understood to say that the greater intensity of this particular poetic feeling is the effect of our scientific progress. It may be to some extent its cause; but it would perhaps be more correct to speak of both as different phases of, and alike due to the influences which have given its special characteristics to the intellectual growth of modern times.

Not only, however, are modern poets distinguished by a deeper feeling for the aspects of external nature; they also observe it with a minute and scientific accuracy. Read, for example, the beginning of Enoch Arden:

> Long lines of cliff breaking have left a chasm;
> And in the chasm are foam and yellow sand;
> Beyond, red roofs about a narrow wharf
> In cluster; then a moulder'd church; and higher
> A long street climbs to one tall-tower'd mill;
> And high in heaven behind it a gray down
> With Danish barrows; and a hazel-wood
> By autumn nutters haunted flourishes
> Green in a cup-like hollow of the down.

What completeness in the details of this picture? You would know the place if you happened to visit it.

Read also for example the following passage from Marmion, descriptive of the hero's journey on the day after leaving Norham Castle.

> Oft on the trampling band, from crown
> Of some tall cliff, the deer looked down;
> On wing of jet, from his repose
> In the deep heath, the black-cock rose;
> Sprung from the gorse the timid roe,
> Nor waited for the bending bow;
> And when the stony path began,
> By which the naked peak they wan,
> Up flew the snowy ptarmigan.

There are no generalities here; the description is marked by exceeding accuracy; Scott had himself seen these details with delight and reproduces them with pleasure.

But of all modern English poets Wordsworth is perhaps most distinguished for the love of nature. He spent his life in one of the most beautiful parts of England and composed much of his poetry out of doors. He tried in prose to give expression to his theory of the essential beauty of the commonest sights. His poems show how he loved the external world, not only in its general aspect but in its minute details. They likewise show that he was inspired by a love of nature for herself which was entirely independent of any meaning he saw in her. He says:

> The sounding cataract
> Haunted me like a passion; the tall rock,
> The mountain, and the deep and gloomy wood,
> Their colours and their forms, were then to me
> An appetite, a feeling and a love,
> That had no need of a remoter charm
> By thought supplied, or any interest
> Unborrowed from the eye.

Very many of us now share this mental attitude; but that should not lead us to forget that as a prevailing habit of mind the love of nature has gained greatly in depth and range in the last century. It is only within that period that the love of scenery has appreciably influenced the travelling public. It may be that previously the difficulty of going from place to place was so great as effectually to nip in the bud any nascent taste for natural scenery; but this explana-

tion does not fully account for all the facts. The ancients, like the moderns, were accustomed to go in great numbers to pleasant places that were easy of access; but we do not hear of their going at the expense of great physical discomfort to spend a night on the summit of a frozen Alp, in order to witness the sun rise from it, or doing anything of a similar character. They loved nature in so far as her aspects suggested comfort and enjoyment; but the whole class of poetic sensations based on the feeling of man's oneness with the rest of the universe was almost entirely absent from their souls.

Another important feature in the literary history of the nineteenth century which is, I think, connected with the predominance of physical science in the intellectual world is the production of a considerable mass of verse which may be classed as the poetry of doubt and negation. The leading feature of the poems belonging to this class is that they deal with the religious aspect of the general scepticism due to the scientific method. The prominent English names in this school are Shelley, Tennyson, Arthur Hugh Clough, and Matthew Arnold. Tennyson, indeed, falls into this class not on account of the general character of his works, but on account of one single poem, *In Memoriam*. That, however, is his best. The connexion of the scepticism, which he fights and overcomes in that poem rather by force of will than by argument, with the scientific movement is shown by innumerable passages, many of which have become stock quotations. Here is one of the most familiar:

Are God and Nature then at strife
  That Nature lends such evil dreams?
  So careful of the type she seems,
So careless of the single life,

That I, considering everywhere
  Her secret meaning in her deeds,
  And finding that of fifty seeds
She often brings but one to bear.

I falter where I firmly trod.

Matthew Arnold has, like Tennyson, fought his doubts and overcome them; but he has arrived at a much less definite belief.

Clough and Shelley both died before reaching any very defined belief. The nature of the former made him a pure doubter; that of the latter an asserter of negations. Shelley is not so much a poet of doubt as of defiance.

No one who narrowly scrutinizes the intellectual influences of our own day can fail to see that that of science is one of the most important. One scientific speculation, that of Charles Darwin on the origin of species, has within less than a quarter of a century completely revolutionized the world of thought. The frequency with which such words and phrases as, development, evolution, survival of the fittest, struggle for existence, etc., are now used in our newspapers and in ordinary conversation, is perhaps the most striking proof of the extent to which the world generally has been unconsciously influenced by him. Nearly all the leading scientific men of the age are Darwinians; the only exceptions are a few of the older men who still keep their heads above the advancing tide. This theory seems to strike at the belief in personal immortality and the other foundations of morals and religion; and some writers, notably Mr. Goldwin Smith, have given expression to the opinion that a day of moral unsettlement and consequent deterioration of hunan conduct is approaching. They would reëcho what Tennyson has expressed in *In Memoriam.*

I trust I have not wasted breath:
  I think we are not wholly brain,
  Magnetic mockeries; not in vain,
Like Paul with beasts, I fought with death.

Not only cunning casts in clay:
  Let science prove we are, and then
  What matters science unto men,
At least to me? I would not stay.

Let him, the wiser man who springs
  Hereafter, up from childhood shape
  His action like the greater ape,
But I was born to other things.

Such lamentations appear to have little effect upon the advance of evolutionist views. Like some necromancer whose spells have evoked a spirit which he cannot lay, the activity of the human intellect has developed a system of beliefs with regard to the material universe that seems to threaten the very foundations of society, and we can do nothing but look on. Yet I, for one, have no serious apprehensions. I believe

That somehow good
Will be the final goal of ill.

The presence of the religious and moral elements in man is at least as much a fact as the links of resemblance that establish a relation

between us and the anthropoid apes. If the analogies of our physical nature connect us with the earth, those of our spiritual nature join us with the skies. The Power that rules the universe governs not only us but everything in it, including the causes and effects of the promulgation of the Darwinian theory, and it seems therefore unreasonable to be over-anxious because we cannot see how the breakers, or appearances of breakers ahead are to be avoided. We are looking at a single scene of the great drama of human progress, and though I do not know what is going to happen in succeeding scenes and acts, I have an abiding faith that what does happen will be right.

But, if the great advance of science has produced some effects that seem of doubtful benefit, of what incalculable value has it not been on the whole? It has in may ways mitigated or nullified pain; it has procured for us innumerable physical comforts; it has lengthened life; it has built up the confidence and increased the energy of man by causing him to believe that his control over the forces of nature may be indefinitely increased. But on these things I shall not dwell for science has won greater victories. Its discoveries have furnished subjects of contemplation that have solaced innumerable spirits in the hour of misery, that have elevated the mean, and given breadth to the narrow, that have shamed men out of selfishness, and added a new force to every lofty and honorable impulse. In comparison with the vast extent of the physical universe how small is my material being, but how grand that part of my nature that makes me intellectually monarch of all that the mental eye can see. Into remote spaces whence it takes light millions of years to come, I range in thought; I view the smallest object visible under the most powerful microscope and yet see further with the eye of the mind; I trace the history of the earth from its original completely molten state down through successive stages of cooling to the present, and onward through innumerable æons in the future, by virtue of my power of intellectual vision. In presence of the sublime conceptions to which such excursions into the infinite realms of time and space give rise, one learns to look down on the petty annoyances of the day, one rises superior to temptations, nature becomes a temple, and life a poem.

SOME NEW
EMENDATIONS IN SHAKESPEARE.

BY E. A. MEREDITH, L. L. D.

In 1623, just seven years after Shakespeare's death, John Heming and Henry Condel "set forth" the first collected edition of the poet's plays—the famous "First Folio," so frequently referred to by Shakespeare commentators. In their preface to "The great variety of readers from the most able to him that can spell," as they quaintly phrase it, they say, "you have been abused with divers stolen and surreptitious copies maimed and deformed by the frauds and stealth of injurious impostors:" "whereas," they add, "those now offered to your view are cured and perfect of their limbs, absolute in their members, as he (Shakespeare) conceived them." After deploring the fact that Shakespeare had not lived to set forth and oversee his own writings, they add, by way of further recommending the accuracy of their own work, "We have scarce received a blot on his papers." From this it would naturally be supposed that the editors enjoyed the special advantage of printing from Shakespeare's own manuscript—a supposition the more likely, as the editors had been his intimate companions and were privileged to speak of the poet as their "friend and fellow." As a matter of fact the editors of the "First Folio" do not appear to have had any such advantage, for Professor Dowden, perhaps the highest authority on such a question, assures us that "several of the plays in the 'First Folio' are in fact printed from earlier Quartos, while in other cases the Quartos gave a text superior to the Folio."

If Heming and Condel were the first Shakespeare editors to mourn over the corruptions and mutilations which the text of their author had undergone, they most certainly were not the last. From that day to this these corruptions have not ceased to perplex the editors of Shakespeare and to furnish an inexhaustible field for the ingenuity of his innumerable commentators.

If we are correct in ascribing to Shakespeare the well-known epitaph on his tombstone cursing any one who should disturb his bones, we cannot but regret that the poet who concerned himself so much about the safeguarding of his earthly part, should have taken so little thought about his literary remains. Never, perhaps, were literary pearls cast before swine more recklessly than by Shakespeare. Referring to the infinite variety of influences which contributed to the corruption of Shakespeare's plays, Johnson truly says, "It is not easy for invention to bring together so many causes concurring to vitiate a text." Illiterate copyists, blundering printers, stupid players, all took part in the work of destruction. Small wonder that so large an amount of alloy has come to be mixed up with the pure gold of Shakespeare. The wonder is rather that the mutilation and destruction was not more disastrous and complete. In the work of reverently restoring the original text of our poet, of recovering his lost pearls, all the great English commentators from Rowe and Malone down to our own time have lent their willing aid. Specially during the last quarter of a century has the work of restoration been helped forward by such scholarly critics as Dyce and Staunton, to say nothing of the ingenious Collier, of somewhat questionable honesty.

Although much has been done, still very much remains to be done before the text of Shakespeare can be purified altogether of its dross. There is still no lack of confessedly spurious passages to provoke and reward felicitous conjecture. The present paper is my second contribution to this pious work.[1] The emendations which it contains, original so far as I know, will be found, it is hoped, to clear away some of the errors of copyists and printers. The textual changes are for the most part slight, sometimes merely the alteration of two or three letters or the transposition of two consecutive words.

Turn we to "The Tempest," usually placed first in the old editions of Shakespeare, although it is now universally admitted to have been one of his latest plays, in Professor Dowden's opinion possibly his very latest. Act II., sc. 11—*Trinculo loquitur*—He has come upon the monster Caliban stretched upon the ground partly

[1] A paper on the same subject was read before the Literary and Historical Society of Quebec, and published in the Transactions of the Society for April, 1863.

hidden by the logs of wood which he had been carrying to Prospero's cave, and which he had thrown down in terror on seeing Trinculo.

"What have we here—a man or a fish—dead or alive? Were I in England now, &c., then would this monster make a man. When they will not give a doit to relieve a *lame* beggar, they will lay out ten to see a dead Indian." I venture to suggest that Shakespeare wrote *live*, and not *lame*. The two words, if carelessly written, look very much alike, but *live* seems the natural and true word, and gives force to the contrast which the jester Trinculo wishes to draw, viz.: That the English sight seer would spend ten times as much on seeing a *dead* Indian as in relieving a *live* countryman.

The opening speech of Ferdinand in the 3rd Act of the same play contains a line which has been a veritable enigma for the critics. Ferdinand, being commanded by Prospero to pile up a number of logs at his cave, enters carrying one. Pausing in his work he thus soliloquizes:

> "There be some sports are painful,
> But these sweet thoughts do even refresh my labour;
> Most busie least when I do it."

The last line is hopelessly meaningless. To quote Staunton: "It is the great crux of the play. No passage of Shakespeare has occasioned more speculation, and on none has speculation proved less happy. The first folio reads, 'most busie lest when I do it.' The second, 'most busie least when I do it.' Pope prints, 'least busie when I do it.' Theobald, 'most busiless when I do it.'"

All will agree with Staunton that none of the emendations proposed are very happy, and it were prudence, probably, not to attempt to solve a difficulty which has baffled so many. It seems to me, however, clear that "most" and "least" cannot stand together in the line, and that one or the other was written as a gloss for the one which Shakespeare wrote. Either "most busie when I do it," or "least busie when I do it," is intelligible. "Most busie," however, would refer to "these sweet thoughts" of which he has just spoken, and "least busie" to his feelings when at work. "Studio fallente laborem." I am disposed to believe that Shakespeare wrote:

> "But these sweet thoughts do even refresh my labour;
> Most busie—when I do it."

These sweet thoughts being most busy when he was employed at work. Some actor or copyist not understanding busie as referring to these "thoughts," probably wrote "least" as a gloss in his copy, and both words were by the printer incorporated in the text.

It is not a very uncommon thing for a gloss or a stage direction to find its way from the margin into the text. We have an illustration of the latter, if I am not mistaken, in the commonly received reading of a line in the opening scene of the second Act of Henry V., Corporal Nym, loquitur.

> NYM.—"For my part I care not, I say little;
> But when time serves there shall be smiles."

The last word in the second line, "smiles," was, I take it, a stage direction at the end of the line. Nym. merely says "there shall be ——," without saying what. It is his "humour" to "say little," but he "smiles" significantly, as though he could say a good deal if he would. The line as usually given, "we shall have smiles," seems weak and not in Nym's vein.

By the way, I am not aware whether it has been suggested, that Corporal Nym, whose "honesty" was of the Falstaff type, derived his name from an old and now utterly obsolete English word "Nimm," to *take*. The name being thus an index to the character, as in the case of "Pistol," "Quickly" and "Doll Tearsheet" in the same play.

In first part Henry IV., in the last line (Act III., s. 11), in Prince Harry's speech, "If not the end of life cancels all *bands*." I think we should certainly read *bonds* for *bands*. Cancelling *bands* is hardly intelligible, but *cancelling bonds* is technically correct. Shakespeare uses the same phrase twice elsewhere. In Richard III., we have "cancel his *bonds* of life," and in Cymbeline, "cancel these cold *bonds*." Oddly enough in the previous part of this very speech the Prince distinctly speaks of other legal instruments:

> "Percy is but my factor. Good, my lord,
> To *engross* up glorious *deeds* in my behalf."

In this connection I need hardly mention that the frequent and correct use by Shakespeare of technical legal phrases has been adduced as an evidence that Shakespeare must have spent some years as a clerk in a lawyer's office.

In Richard II. there are two or three of the finest passages in the play in which I venture to suggest emendations. The first occurs in the splendid and patriotic speech which Shakespeare puts into the mouth of old John of Gaunt, when on his deathbed, he utters his last warning counsel to the weak young king, Richard II. (Act II. s. 1.) It is the oft-quoted speech beginning, "Methinks I am a prophet, new inspired," then follows his magnificent description of England:

> "This sceptred Isle,
>
> . . . . .
>
> This fortress built by nature for herself
> Against *infection* and the hand of war."

Staunton objects, rightly I think, to the word "infection," because, as a matter of fact, England in Shakespeare's time was not preserved by her insular position from pestilential contagion. But apart altogether from this very matter of fact argument I cannot bring myself to believe that Shakespeare ever thought of regarding the "silver sea" in which England was set, the "triumphant sea" as it is called in the same speech, as a "cordon sanitaire" to protect the country from the plague! This were on a par with using "Imperious Cæsar dead and turned to clay, to stop a hole to keep the wind away." Farmer, feeling the necessity of an emendation here, proposed the word *infestion*—a word not found, so far as I know, anywhere else either in Shakespeare or any other English writer. "Invasion" was, I believe, the word written by Shakespeare. "Against invasion and the hand of war" brings the line into harmony with the whole speech.

In King Richard's speech, in the same scene, he is made to say:

> "Now for our Irish wars;
> We must supplant these rough rug-headed kernes,
> Which live like *venom* where no *venom* else
> Hath privilege to live."

"Living like venom" appears to me harsh and forced, if not obscure. I suspect Shakespeare wrote "vermin" not "venom," alluding to the legend, popular then as now, that St. Patrick had "banished all the vermin" from the Island of Saints. It may be noted too that Richard proposes to deal with the "Irish kernes" very much as the Saint had done with the Irish vermin, namely, "supplant them," or, in other words, exterminate them—a mode of dealing with the Irish which has probably suggested itself to the

minds of many of the English rulers of Ireland since King Richard's day.[1]

Turn we now to what Professor Dowden calls the "dark and bitter" comedy of Measure for Measure, a play which enjoys the unenviable distinction of having more manifestly corrupt passages than any other of Shakespeare's plays, excepting perhaps "Cymbeline." Claudio when deprecating the cruelty of the Duke's Deputy in enforcing against him the penalty of an obsolete statute, in consequence of his having had a child by Juliet says, Act I. s. 3:

> "And the new Deputy now for the Duke,
> Whether it be the fault and glimpse of newness,
> Or whether, &c."

The meaning of *glimpse* in this line I fail to see, and would suggest that Shakespeare must have written not *glimpse* but *gloss—gloss of newness* is most natural in speaking of the sudden accession of new dignity to the Deputy. It is worth noting too that in several other passages "gloss" and "new" are brought into close conjunction by Shakespeare.

In Much Ado, we have "*new gloss* of your marriage;" in Macbeth, "be worn now in their *newest gloss*;" in Othello, "content to slubber the *gloss* of your *new* fortunes."

Gloss written or printed with the long *s* might readily be mistaken for glimpse, especially when the former word was spelt with an *e* at the end, as it certainly was by Shakespeare.

In Claudio's speech, immediately preceding the one in which this line occurs, I would suggest the omission of "the" in the fourth line, which now stands:

> "Save that we do *the* denunciation lack."

"The" is not necessary here for the sense and spoils the rythm of the line, and I believe we are justified in suspecting any line in Shakespeare which is unrythmical as being corrupt.

[1] Since writing the above my attention has been called to some passages from the literature of Shakespeare's time. which certainly support the present reading.

> "That Irish Judas,
> Bred in a country where no venom prospers
> But in his blood."
>
> *Dryden.*

And in Pier's Ploughman we have

> "Of all freting venymes, the vilest is the Scorpion,"

Where "venym" is clearly used as the animal not the poison.

I cannot help referring to a remarkable instance which this play affords of a corrupt passage being retained in the text long after the obviously true reading had been suggested. See III. Act, s. 2:

ELBOW.—"He must before the Deputy, &c.
The Deputy cannot abide a whoremaster."

DUKE (*who is now aware what a hypocrite the Deputy is*) says:
"That we were all as some would seem to be,
Free from our faults as *faults from* seeming free."

The last line is sheer nonsense, and the ingenuity of all the commentators from Warburton to Staunton has failed to extract any sense from it. The simple transposition of *faults* and *from* in the latter part of the line makes the whole passage perfectly clear, and gives exactly the idea in the mind of the Duke, namely, that Angelo *was not as faultless as he seemed to be.* The same opinion of Angelo is expressed by the Duke in other passages of the play:

"Hence we shall see
If power change purpose what our seemers be."

And again, when he says:

"O, what may man within him hide,
Tho' angel on the outward side."

When it occurred to me many years ago thus to correct the line, I jumped at once to the conclusion that the suggestion had never been made before. For if made I thought it could not but have been immediately adopted. What was my surprise then to find that the suggestion had been actually proposed by Hamner, a very sensible fellow by the way, more than 100 years ago. The correction has not even now been generally adopted in the recent editions of Shakespeare, which aim at special accuracy in the text. The celebrated "Globe" edition of Shakespeare, published within the last twenty years, marks the passage with an obelus (†), indicating that it is a corrupt one for which no admissible emendation has been proposed.

Let us take up now the tragedy of Macbeth, and turn to the king's speech (Act I., s. 4), which he addresses to Macbeth returning after his victory:

"O worthiest cousin.

. . . .

Would thou hadst less deserved
That the proportion both of thanks and payment
Might have been *mine.*"

"For *mine*," says Staunton, "which no one can for a moment doubt to be a corruption, we would suggest that the poet wrote *mean*, *i.e.*, equivalent, just and the like, the sense being, that the proportion of thanks and payment might have been equal to your deserts." I cannot think Staunton as happy as usual in this emendation. The word Shakespeare wrote here was, I suspect, "more," not "mine," or "mean." The substitution of more makes the passage clear. Had Macbeth's deserts been *less*, the proportion of the king's thanks and payments would certainly have been *more*. What immediately follows confirms this correction, for the king goes on:

> "Only I have left to say,
> *More* is thy due than *more* than all can pay."

As an instance of the absurd rubbish, absolute jargon, which the printers were ready to give as Shakespeare, I may cite a line from a speech of the witty Mercutio as it is given in all the old editions but one—

> "Cry but 'ah me'—Provant but love and day."

The true reading being—

> "Appear thou in the likeness of a sigh,
> Speak but one rhyme and I am satisfied,
> Cry but 'ah me,' pronounce but *love and dove*."

The *ah me* is the sigh, *love and dove* stands for the rhyme. Oddly enough, "ah me" is the very first word which Juliet speaks or sighs as she enters in the next scene.

It is no part of such a paper as the present to lay down any general canons of criticism on the subject of Shakespearean emendations. But the following *dicta* will, I venture to think, be accepted by most Shakespearean students:

1. That the sole object and justification of any emendation in the text of Shakespeare, should be to eliminate any thing which Shakespeare did not write, and to substitute if possible the *ipsissima verba* of the author.

3. That any passage which is obscure and unintelligible may be assumed to be *corrupt*.

3. That any line which is not rhythmical may be suspected not to be Shakespeare's.

The first and second of the foregoing propositions will, I think, commend themselves to most Shakespearean scholars. The second

is in truth a corollary of the proposition, which is I think unquestionable, "That nothing which is obscure is Shakespeare."

As to the third, it is only another way of stating that Shakespeare was such a master of rhythm, his musical ear was so correct, that he could not write any thing which was harsh or unmusical.

When, therefore, we are startled by any line which lacks the usual melody and rhythmical flow of Shakespeare, we cannot but regard it with grave suspicion, and if we hesitate to pronounce it as *ipso facto* corrupt, we must at least place it in the category of those which are *soupçonnes d'être suspects.*

But besides the obscure and unmusical lines there are no doubt many others which are corrupt. The accomplished editors of the Cambridge Shakespeare truly remark: "There are many passages, easily construed and scanned, and therefore not generally suspected of corruption, which nevertheless have not been printed exactly as they were written. Some ruder hand has effaced the touch of the master." Some of these unsuspected corruptions have been dealt with in this paper.

When I consider the scholarship and learning expended during the last quarter of a century, both in Europe and America, upon the works of Shakespeare, the volumes which have been written on his genius, mind, art and influence, the subtle sometimes perhaps too subtle—analysis to which the principal plays and characters have been subjected, to say nothing of the recent contribution to Shakespearean literature in connection with what has been well called the Bacon-Shakespeare craze, I cannot but be sensible of the comparatively humble field of enquiry to which my Shakespearean labours have been directed. Indeed, I feel that to speak of what I have done as "labour" at all may be to give to it a dignity to which it has no claim. But if it may be so designated, it has assuredly been a labour of love, where the labour was its own reward. If I could hope by my suggestions to remove even one or two of the blemishes or obscurities which mar and disfigure the bright page of Shakespeare, I shall have the further satisfaction of feeling that I have done something to mark, however feebly, my gratitude for the infinite enjoyment and instruction which I have derived from his plays.

THE
NASAL REGION IN EUTAENIA.

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The original object of the present paper was a description of the Organ of Jacobson as it obtains in Eutaenia. During the progress of my studies in that direction, however, new features and modifications of previously described structures in the nasal cavity, lachrymal duct, and on the palatal surface, were observed, and I felt compelled, in consequence, to abandon that limit, and to include below a description of the whole Nasal Region.

The material for study consisted of a series of sections from an embryo-head, 6 mm. in length, of Eutaenia sirtalis, and several series from the nasal region of adult forms of the same species. In addition to these, I have examined many of the parts in question in fresh state in salt solution, and also when macerated. A number of macerating reagents were employed, but treatment with Müller's Fluid and subsequent staining with an alcoholic solution of Eosin, gave the best results.

I must here express my sincere thanks to Prof. Wright for the kind advice and assistance received from him on points of this work, and especially on the Organ of Jacobson, the structure of which I have studied with him in his own laboratory. I am also indebted to him for several of the drawings accompanying this paper.

The roof of the mouth in the adult possesses several strongly marked ridges and depressions. Of the former there are two on each side of the middle line, that over which the maxilla lies being the most prominent throughout. It runs parallel with the lip, and does not unite with its fellow of the opposite side in front. The palatine ridges commence some distance behind, are parallel to each other, and bound a depressed palatal surface. Between the maxillary and palatine ridges of each side lies another longitudinal depression whose surface is striated, the course of the striation being obliquely

backwards and inwards across the axis of the depression. (Fig. 1.) It is due to a folding of the mucous membrane into crypts. The middle palatal depression is bounded anteriorly by a raised portion of the palate from which a crest, large, rounded in front, is continued, diminishing in height as it proceeds backward. Behind the palatal depression lies the choanal region, oblong in shape, and much deeper than the rest of the upper surface of the mouth. It contains the somewhat crescent-shaped choanae and the choanal cul-de-sac, the latter to be found between two folds separating the choanae, diverging and flattening out posteriorly. At a point on the middle palatal depression on each side of the palatal crest, opposite its posterior termination and adjacent to the palatine ridge, is to be found, in hardened specimens, a very delicate groove, containing the openings of the Organ of Jacobson and the lachrymal duct.

The corneous matter covers the edge of the lips to the lateral border of maxillary ridge. At this junction of the corneous and maxillary regions the apertures of the ducts of the upper lip gland are found.

In a transverse section of the nasal region of the adult, through the middle of the Organ of Jacobson, the latter is situated immediately above the palatine ridge and the middle palatal depression on each side of the middle line, and placed adjacent to the inner wall of the nasal passage, which is here inclined outward and downward. Laterally from the Organ of Jacobson and under the nasal passage lies a cavity with its transverse axis horizontal, which may be termed the maxillary sinus. Above it Müller's Nasal Gland covers the lateral wall of the nasal passage. (Fig. 2, *Mg.*) Immediately above the inner corneous portion of each lip is seen the upper lip gland with several lobules. Below, the maxillary and palatine ridges are strongly marked, and the middle palatal surface has a distinct crest. (Fig. 2, *m*, *p*, and *pc.*)

The vomer is double, each half forming a capsule for the inner and a portion of the under and upper walls of the Organ of Jacobson of its side, and consisting of three portions, a basal not quite horizontal, a thin vertical plate concave on its outer face, and a cupped crest. The inner edge of the septomaxillary, appearing in section as if turned under on itself, rests on the cup of this crest, and the septomaxillary is continued from here outwards between the Organ of Jacobson and the nasal passage. Under the latter, it gives two

plates, one to proceed down the outer surface of the Organ of Jacobson, the other, to proceed in opposite direction, on the outer wall of the passage and terminate in the middle of its height. The lower plate is found in other sections to enter the pedicle (Fig. 2, *pd*,) of the Organ of Jacobson, and partly fuses there with the basal portion of the vomer. In the section represented it does not so enter, its place being occupied by the cartilage which passes out from the pedicle and lines the outer under face of both plates of the septomaxillary, and ultimately in sections behind this reaches the turbinal ingrowth, with the cartilage of which it unites. (Figs. 2, 3, 4, *tb.*) The upper half of the pedicle is filled with cartilage throughout, (*tb'* 2, 3.) The turbinal cartilage extends over the nasal cavity to connect in front with the wing of the nasal septum, which terminates inferiorly with a rounded edge between the cupped crests of the vomer of each side. (Figs. 2, 3, 4, *Sept.*)

In a section through the anterior termination of the maxillae, the latter with the premaxilla form a horizontal plate with a plate of cartilage, also horizontal, in its centre. In a section behind this the cartilage is concave on its upper face, and the osseous piece above it, is the ascending process of the premaxilla. Below, are two basal pieces, not distinctly separated from each other, or from the maxillae now somewhat laterally. Behind this again the cartilage takes a U form, the wings of which give off on each side a nearly vertical transverse plate, forming a prenasal wall, and reaching the cheek in front of the anterior nasal opening. Between the wings of the main cartilage, now the nasal septum, the ascending process of the premaxilla extends and forms a vertical plate. (Fig. 6, *pra.*) Immediately behind the transverse prenasal wall of each side, the septomaxillary commences rod-like, and separated from the similarly shaped vomer by a thin sheet of cartilage continuous with the transverse prenasal wall. The basal portions of the premaxilla (*prb*) do not extend much further behind this point. The septomaxillary becomes flattened as it proceeds backward, its transverse axis directed outward and downward, and applied in this manner to the wall of the nasal cavity. It is still separated by the cartilage, above described, from the vomer. When the Organ of Jacobson is reached, the septomaxillary has acquired considerable thickness and forms its anterior wall, while the cartilage enters the pedicle, in the anterior half of which the two mentioned bones fuse, although incom-

pletely. The septomaxillary undergoes another change in form at the hinder half of the Organ of Jacobson it gradually loses the prolongation on the outer and under surface of the Organ, which is there replaced by the vomer. It also rises and becomes more closely applied to the nasal wall. On the other hand, the cupped crest of the vomer becomes prolonged outward under the septomaxillary and parallel with it. This portion of the vomer is much fenestrated to allow a passage to the Organ of Jacobson for the olfactory nerve bundles. Below, the basal portion reaches outward, and finally unites with the superior prolongation on the outer surface of the Organ.

The vomer thus surrounds and envelopes the posterior, as the septomaxillary does the anterior, termination of the Organ of Jacobson, behind which it divides into two portions, the inferior quickly disappearing, the superior losing its horizontal process rises, and with its fellow of the opposite side forms a capsule for the lower half of the nasal septum, now oval in section. Approaching the choana of its side, it descends again to apply itself to its inner wall, and terminates by sending a plate outward over the choanal roof to unite with the palatine bone.

As before stated, the wings of the nasal septum pass out over the nasal cavities down their sides to connect with the turbinal cartilages. The latter are provided in their front half with a concavity on the outer face of each, to which the Nasal Gland of Müller accommodates itself. This concavity deepens as the cartilage is followed backward, the edges approximating and forming ultimately behind a closed tube, containing a separate portion of the gland. (Fig. 4, *Mg'*). This tube ends blindly with the turbinal ingrowth.

In front a plate of cartilage, continuous with the turbinal, passes around the nasal opening, and is connected with the transverse prenasal wall. (Figs. 6, 7, *nc*, *nc'*.) Below, the turbinal is connected with the cartilage of the pedicle of the Organ of Jacobson by a narrow transverse plate passing under the septomaxillary. This transversely directed plate of cartilage is continued backward into two pieces, which in a transverse section containing the opening of the Organ of Jacobson are arranged, one immediately under the outer half of the latter, the other some distance laterally. (Figs. 3, 4, *lc'*, *lc''*.) These are the lachrymal cartilages, and are described below in connection with the lachrymal duct.

The nasal bones immediately succeed the ascending process of the premaxilla. They reach down between the wings of the nasal septum, and do not pass out farther than the superior border of Müller's Gland. Posteriorly, each have a process directed downward to unite with the process of the inner edge of septomaxillary, when the plate of the latter disappears behind. (Fig. 4, *na.*) This inferior process is continued into the rostrum of the frontal bone of the same side.

In the same section as at first examined, viz., that through the middle of the Organ of Jacobson, the mucous membrane of the roof of the mouth differs in structure at the following points:

(α) At the inner surface of the lip, where large nucleated cells are overlaid by a corneous stratum; the cells at the base, while of the same size and shape, are more granular in contents.

(β) In the immediate neighborhood of the furrow, in which the ducts of the upper lip gland open; there the corneous layer is replaced by flattened, apparently squamous, cells overlying a layer of small oval cells. This is the structure of the membrane on the middle palate and in the dental pits.

(γ) In the palatine crypts, where goblet and ciliated cylindrical cells alone are found, the latter being to all appearance the more numerous.

(δ) At the passage from one palatine crypt to another, where the membrane is formed almost wholly of ciliated epithelium cells, with here and there a goblet cell.

The furrow to be found limiting the inward extension of corneous layer of the lip receives at regular intervals the apertures of the ducts of the upper lip gland. From here the ducts lead upward and outward, and break up into a number of acini. Immediately above the lobule thus formed are to be found the sections of preceding or succeeding lobules, three or four in number. The cells of the acini in the uppermost lobules are of larger size than those of the lower. The nucleus in each is generally situated in the outer half of each cell, the contents of which are more or less granular, and slightly pigmented, giving to the gland, as a whole, a yellowish tinge. When removed in a state of active secretion, the cells of the gland are found to be extremely granular. As these approach the main duct they elongate and become cylindrical. The acini are compressed against each other, thus becoming polygonal in section and are separated by small quantities of nerve fibres and connective tissue.

The gland extends from the transverse prenasal wall to a point immediately behind the fleshy union of the jaws. The lobules are larger and reach higher as they are followed backward.

A large gland fills up the space between the cartilaginous prenasal wall and the apex of the snout. It is termed the "snout gland," and and is shown by Reichel to be but a separately developed portion of the upper lip gland. Its ducts open in the depressions placed laterally from the head of the palatal crest. This shows it to be a paired gland, but the acini of lobules from one side are directed in every manner amongst those of the other side; as Reichel points out, they are quite separate at an early stage. The cellular structure is very similar to that of the upper lip gland, and possesses also the yellowish tinge. The lobules reach up nearly to the posterior end of the ascending premaxilla.

The Nasal Gland of Müller is situated on the lateral wall of the nasal cavity, from which it is separated by the turbinal cartilage, and the septomaxillary; as already described, it conforms itself to a concavity on the outer face of turbinal cartilage. As the concavity deepens to form a tube, a portion of the gland is included in it to its blind termination. It does not reach farther behind than the turbinal ingrowth, and anteriorly than the Organ of Jacobson. The duct, however, is continued, first on a level with the turbinal ingrowth, then on the lower outer surface of the nasal wall, which position it keeps till it reaches the anterior nasal opening, on the lower posterior edge of which is found its flask-like aperture. Fig. 7 is a representation of a transverse section at this point, with *ap* the aperture over a broad groove, which in front of this forms the floor of the nasal cavity.

The cells of this gland are provided with large distinct nuclei and a protoplasm but little granular and staining very deeply. Their shape is generally cubical, approaching to cylindrical. The acini are arranged in horizontal layers separated by connective tissue, nerve fibres and capillary vessels, and are perfectly circular in transverse section. The main duct is continued behind, about the centre of the gland.

The mucous membrane lining the floor of the nasal passage is folded in a remarkable manner, reaching out into and narrowing its lumen; its constituents are ciliated cylindrical cells and goblet cells. Below these is found a layer of cells whose characteristics change

with their situation, oftenest of small spherical form and granular contents.

The olfactory portion of the wall of the cavity may be divided for the purpose of description as follows:

(α) The mucous stratum, lying adjacent to the cartilaginous plate; it is constituted of large pigment cells, nerve fibres and capillaries, forming a plexus, which surrounds the branch tubules of Bowman's glands.

(β) The sensory stratum, resting on *a*, which is composed mainly of the nuclear portions of the sensory cells, arranged in 8–10 layers. The central processes of these are much more delicate than the peripheral, and in many places in my preparations are seen to be continuous with olfactory nerve fibres. The peripheral processes exhibit a marked wavy contour, and in specimens, subjected to the action of Müller's Fluid, appear possessed of granular contents. Outside and beyond the cells of γ, these abruptly become slender, forming the so called sense hairs, (the Riechhärchen of Max Schultze) directed into the nasal cavity. These, when examined in salt solution, exhibit considerable movement, their axes becoming every now and then wavy. At their origins are to be observed delicate swellings. The nucleus of the sensory cell is perfectly spherical, and, like the protoplasm surrounding it slightly glanular.

(γ) The superficial stratum, composed of cylindrical epithelium cells with oval nuclei lying between the peripheral processes of β. The central ends of these are very delicate, and are not branched. I have not observed any longitudinal striation on their surface. Forming the outer terminations of these cells and encasing the delicate swellings of the sense hairs, is seen, with favorable light, a distinct border structure, corresponding to a *membrana limitans olfactoria*. Through this the protoplasm of the cylindrical cells sends out excessively fine cilia which are seen in their entirety in salt solution, but when macerated, too often form only a granular precipitate at the border of the cell. They do not reach nearly the same length as the sense hairs, and exhibit a very slow movement, their axes remaining perfectly straight all the while. Sometimes these are obscured by the mucous and mucous cells from the adjacent glands.

At the junction of the olfactory with the mucous portion of the nasal wall a great development of Bowman's Glands is to be observed; their size here is extraordinary compared with those of other portions. They are composed of cells of two forms, those in the depth of the gland being large and almost spherical. As they approach the aperture of the gland they gradually become smaller, assuming a rhombohedral form. The large cells in ordinary stained preparations do not show

nuclei, but after a stay in Müller's Fluid the nucleus is found adjacent to the wall of the now perfectly spherical cell. The opening of the gland takes place at an indentation on the surface of the membrane.

The following account of the structure of the Organ of Jacobson based partly on my preparations, was contributed by Prof. Wright to the *Zoologischer Anzeiger* (No. 144), and will serve to explain his figures (Nos. 8, 9, 10):

> "The Roof.—Immediately within the osseous capsule which the Vomer forms for Jacobson's Organ lies a somewhat scanty mucosa which is largely occupied by olfactory nerve-bundles: it is more richly pigmented than the corresponding layer in the nasal cavity, its blood-vessels are of larger calibre, and it is destitute of Bowman's Glands. Most of the elements of the mucosa are continued inwards towards the lumen of Jacobson's Organ between its cellular columns which are thus isolated from each other by pigmentary connective-tissue and capillary vessels. Very few of the olfactory nerve-fibres appear to run in the partitions thus formed, the bundles entering the outer ends of the cellular columns almost entirely. The capillaries arrived at the deep surface of the *Neuro-epithelium* form there a plexus, the polygonal meshes of which are occupied by the inner ends of the cellular columns. This plexus obviously corresponds to that on which the Neuro-epithelium in the nasal cavity rests; but there is no intervening basement membrane, for a reason which will be presently apparent. The *Neuro-epithelium* (inside the plexus) is only 33 μ high, and the greater part of this belongs to the superficial stratum (as defined above), while only one or two layers of cells corresponding to the nuclear are to be detected. These latter cells, however, differ in form, according as they stand opposite a node or a mesh in the capillary plexus; in the former case they are shorter, and their deep processes are bent in such a manner as to pass around the vessel, in the latter case they are more fusiform and they retain this shape for three or four layers while passing through the mesh in the corresponding cellular column. With the exception of these spindle-shaped cells which form their inner ends, the cellular columns are formed entirely of cells, completely resembling those of the nuclear stratum in olfactory epithelium of the nasal cavity; *i. e.*, they possess rounded nuclei (6—7 $\mu \times 5 \mu$) surrounded with very scanty protoplasm prolonged into processes at either end. The highest columns measure about 300 μ.
>
> The Floor.—The following structures may be traced from roof to floor.
>
> (1) The layer of ordinary cylindrical epithelium cells which are now only 15 μ high and bear short cilia; between the bases of these are wedged small rounded cells forming rarely more than one layer; these rest on

(2) The capillary plexus, which is directly continuous with that mentioned above; the rest of the mucosa is occupied by

(3) The abundant pigment cells which spread out at the junction of floor and roof to surround the cellular columns in the mode described above."

Prof. Wright's and my own studies further on the same subject have given the following:

The sensory stratum is divided into (1) the cellular columns already mentioned, oblong in section in the body of the organ, but at its posterior termination, polygonal, completely surrounded by the constricting plexus at all but one point, where their cells pass gradually over into those of (2) the sensory portion adjacent to the superficial stratum, and consisting of two or three layers. The cells of the second portion of this stratum do not exhibit any difference from the sensory cells of the nasal passage, except that the nucleus in each and the portion of the cell containing it are more or less fusiform. In those of the columns, however, the central and peripheral processes are undistinguishable, so far as shape is concerned, both exceedingly delicate and wavy in their course. When the columns, macerated in Müller's Fluid, are teased out, minute portions will be frequently seen through which the delicate processes pass in every direction. The nucleus in each is large, distinct and quite spherical, with little protoplasm surrounding it. Through the point of the connection of the columns with the rest of the sensory cells, their peripheral processes reach down between the latter to the lumen of the organ and terminate like them.

The terminations of the sensory cells in the lumen are knob-like and about one-fourth the length of the sense-hairs in the nasal passage. With such a length all capability of movement is absent. There is no swelling to be observed at the base of each.

In the superficial stratum the cells have the same shape as in the nasal cavity. They are provided with the same distinct border structure, through which the sensory terminations push. Of any prolongation of the protoplasm of the superficial cells beyond this border structure no convincing proof has been met with as yet. In several cases a faint striation parallel with the cylindrical cell was observed at its border. This was replaced by a delicate granular precipitate in macerated specimens. The number of cases in which such a striation was observed, were few in comparison to the amount of material examined. It is, however, quite probable that the cylindrical cells are provided with cilia as excessively fine as these of the nasal cavity.

The border structure must be regarded as the homologue of the *membrana limitans olfactoria* of the nasal cavity.

The contents of the nerve-bundles near their origin from the olfactory lobes have a gelatinous appearance, with delicate lines to indicate a division into fibres. Each bundle is provided with a thin cellular sheath, which in cross sections is seen to strike in to form still smaller bundles. The fibres which appear more distinctly some distance down the bundle are non-medullated, but provided with a distinct sheath in which are to be observed here and there spindle-shaped cells, giving often the appearance of swellings on the course of the fibre. In the immediate neighbourhood of the sensory stratum either of the Organ of Jacobson or of the nasal cavity, these appear to be wanting. The diameter of the nerve threads here compared to those of the bundles farther up, would seem to indicate that these are primitive fibrils formed by the division of the contents of the main fibres. These primitive fibrils, if they are such, show no varicosities and give no evidence of any sheath like that possessed by the main fibres beyond having a sharply defined boundary. These fibrils are seen in such a condition when the sensory cells are pencilled out from cellular columns, leaving only a few fibrils. They terminate as far as I can make out from my preparations at the central processes of the censory cell. The process and the fibril are of equal diameter. In sections from the embryo the fibrils appear to end in the nuclear portion of the sensory cell, and then a central process is not percievable. It is impossible to say whether the latter is a structure distinct from the nerve fibril; on the other hand, I have no hesitation in saying that the both are continuous.

The bundles may divide for both the Organ of Jacobson and the nasal cavity. Those for the former are arranged in a fan-shaped fashion. The smaller bundles for the nasal cavity strike in at every angle through the mucous stratum, bending around capillaries and crypts of Bowman till they reach the sensory stratum.

The nasal cavity, in front of its anterior opening, is of the shape represented in Fig. 6. The groove to be found on its floor here runs backward through the opening on the cheek posteriorly. (Fig. 7, *gr.*) Behind this the passage takes a $\widehat{\mathrm{V}}$ form, whose lumen the turbinal ingrowth tends more and more to diminish, and is practically divided by it into two channels, one. the upper nasal chamber, to a great extent lined by the olfactory membrane, and communicating over the rounded edge of the turbinal

with the mucous or lower nasal chamber, whose size is diminished by the mucous folds. The inner wall of the mucous chamber runs into a tube prolonged forward on a level with the Organ of Jacobson, and ending blindly immediately behind it. The tube is succeeded by a groove of the same calibre, which, with its fellow of the opposite side, narrows considerably the fleshy septum. The canal and groove are lined with folded mucous membrane. With the termination of the turbinal the passage becomes smaller and descends to the roof of the mouth to end in the choanae. These, observed from below, are slightly crescent-shaped, and are separated by folds (*Fig.* 1, *chf.*) which contain between them the choanal cul-de-sac, ending blindly in front over the middle palate. The choanal depression is somewhat narrowed below by a fold on each side from the palatine ridge.

It is necessary to add some further details concerning the general histology of the nasal cavity, in addition to what is given above, for one section of it.

In the groove in the floor of its cavity, in front of the nasal opening, the cells of the lining membrane are, passing from its base upward, oval and granular, then large and polyhedral, and covered by a layer of flat corneous cells, the latter several layers thick near the posterior termination of the groove. The whole offers no contrast to that found just inside the lips, except in the size of its constituent cells.

The cavity anteriorly to the Organ of Jacobson is very poor in olfactory epithelium. The mucous membrane is but little folded, and the cylindrical cells with thick cilia appear to wander into the olfactory portion.

Above the Organ of Jacobson the mucous folds of the lower chamber seem to fill it out completely, while the olfactory epithelium does not reach that development which obtains behind. For there the turbinal is of its greatest transverse length, and its rounded edge, like the inner and upper walls of the upper nasal chamber, is lined by well developed olfactory membrane. The superficial and sensory portions of the same are wanting in the floor of the upper chamber. Coincident with the disappearance of the turbinal behind, the olfactory epithelium becomes scanty again, and on the roof and floor of the passage, in the immediate neighborhood of the choana, is replaced by mucous membrane, that lining the roof abounding in goblet cells, while the majority of the

constituents in the floor are formed by ciliated epithelium cells, which are also abundantly found on the palate immediately anterior to the choanae. In the choanal depression, minor folds of the membrane are very abundant. The two large ones separating the choanae enclose a cul-de-sac, whose lining membrane contains a profusion of goblet cells, which, however, give place to ciliated epithelium cells at the opening.

The Organ of Jacobson (Fig. 2, *J. O.*) is with its pedicle of semicircular shape in transverse section, the cellular columns of its roof appearing to radiate about the crescentic lumen of the canal, and to form the greater portion of its bulk. These are of greatest length on the inner and upper side at the opening, behind which they are found on all sides of the now oval lumen. (Fig. 4.) The crescent form of the canal in front is due to the growth inward on its floor of a projection from the palate, and filled out with cartilaginous and parosteal structures as described above. For want of a better term I have called it the pedicle. (*pd.*) It bears a marked resemblance to the turbinal, this similarity being somewhat strengthened when one considers the connection of their cartilages, and that the Organ of Jacobson and the upper nasal chamber are functionally alike. The inner wing of the lumen of the canal becomes prolonged downward between the pedicle and the basal portion of the vomer, and opens in the groove to be found on the border between the middle palate and the palatine ridge. (Fig. 3, *Jop.*) This groove can without much difficulty be seen in hardened specimens, and in fresh ones only when the upper jaws are pressed upward, thus separating the palatine ridge and middle palate and exposing the groove. Behind this opening the pedicle disappears and leaves the canal oval in section. (Fig. 4). On its further course the columns arrange themselves on its under side, and are continued for some distance behind its blind termination.

The lachrymal duct opens on the inner wall of the same groove in which the Organ of Jacobson opens. (Fig. 3, *Lop.*) It runs behind under the organ as far as it is continued behind, when it gives a sharp turn outward toward the palatine bone. A longitudinal section of the duct is illustrated in Fig. 11. There *a* represents the basal portion of the duct which lies partly under the vomer and partly beside the palatine bone, and ends blindly behind (*b*). The main duct is continued upward and outward over the palatine, where a

slight prolongation forward is found (*c*), and which appears in section in Fig. 4. A similar prolongation is found on the level of the turbinal, the cartilage of which furnishes a ledge on which the duct rests for a short distance, after which it is completely surrounded by the lachrymal bone for a portion of its course. As it approaches the eyeball it lowers to its anterior angle, and takes a sharp turn inward and upward to terminate in its gland, situated on the inner surface of the eyeball, and separated from its fellow of the opposite side by the basisphenoidal rostrum.

The cartilages (Figs. 3, 4, *lc'*, *lc''*) which have been termed lachrymal above, are but backward continuations of the transverse band connecting the turbinal cartilage with that of the pedicle of the Organ of Jacobson. When the lachrymal duct has reached the palatine bone, they apply themselves to its outer and under wall and fuse, forming a plate continued behind with the blindly ending basal portion of the duct. The plate behind the latter becomes flattened horizontally, and terminates in front of the choana of its side.

The sections from the embryo head reveal some important points which may be summarized here.

The roof of the mouth exhibits in the main the features of the adult palate. No glandular structures are present, there being but an involution of the lining membrane to form the future upper lip gland. (Fig. 5, *gl.*) The opening of the Organ of Jacobson is situated in the groove to be found laterally from the choanal depression.

The Organ of Jacobson has the same form as in the adult. The cellular columns number about twenty in each section, while in the adult the number reaches sometimes as high as sixty. But the remainder of the roof, of which they are the constricted portions. is much thicker, and in it 8–10 layers of cells may be counted. Neither these nor those of the columns are possessed of peripheral processes, at least such are not demonstrable. Fibres arising from the inner surfaces of the olfactory lobes pass down the sides of the septum, enter the outer ends of the columns, and terminate at its cells. The whole roof does not exhibit, in addition to the division into columns, any difference from that lining the upper nasal chamber. Its floor is lined by two layers of interfitting columnar cells.

The continuity of the cartilage of the Organ of Jacobson with that of the nasal cavity, which only a study of many sections of the adult shows, is demonstrated by one, or at most two sections, from the

embryo head. Fig. 5 is a representation of one of these. The cartilage there seen on the lateral wall of the upper nasal cavity passes down into the turbinal, bends and forms a loop, which is the origin of the closed turbinal tube containing in the adult a portion of Müller's Nasal Gland. It is continued downwards, and after giving off a thin sheet, which is deflected between the Organ of Jacobson and the nasal wall, the main portion reaches the maxillary cartilage, bends horizontally inwards to the pedicle of the Organ of Jacobson, where it turns upward and ends in a thickened rounded edge. I have not found any thin plate separating the nasal wall from the Organ of Jacobson in the adult.

EXPLANATION OF PLATE I.

FIGS. 1, 8, 9, 10 were executed by Prof. Wright. The others were drawn by myself from photographic representations or by means of the camera.

GENERAL.

Ch. .. Choanae.
Chf. .. Choanal folds.
Mdp. .. Middle palate.
M. .. Maxillary ridges of the palate.
P. .. Palatine ridges bounding the middle palate.
Pc. .. Longitudinal crest of the middle palate.
Pa. .. Palatine bone.
Mx. .. Maxilla.
Gls. .. Upper lip gland.
Mg. .. Lateral Nasal Gland of Müller.
J. O. .. Organ of Jacobson.
J. C. . Canal of the Organ of Jacobson.
Pd. .. Pedicle projecting into the floor of the Organ of Jacobson.
Vo. .. Vomer.
Tb. .. Turbinal cartilage.
Tb'. .. Cartilage of the pedicle of the Organ of Jacobson.
Sept. .. Nasal septum.
Spx. .. Septomaxillary bone.
Spx'. .. A portion of the vomer replacing the septomaxillary.
Na. .. Nasal bone.
Pra. .. Ascending process of the premaxilla.
Lc', lc''. .. Lacrymal cartilages.
Lop. ... Opening on the mouth of the lachrymal duct.
Lc. .. Lachrymal duct.
Op J. .. Groove into which the canal of the Organ of Jacobson opens.
Olf. .. Olfactory lobes.

Nc, nc.' .. Cartilage surrounding anterior nasal opening.

Tr. .. Transverse plate of cartilage passing from the pedicle of the Organ of Jacobson to the turbinal cartilage.

Unc. .. Upper nasal chamber.

Lnc. .. Lower nasal chamber.

FIG. 1.—A view of the roof of the mouth in Eutaenia sirtalis; several times magnified.

FIG. 2.—A transverse section of the nasal region through the middle of the Organ of Jacobson. x 20.

FIG. 3.—One half of a transverse section of the nasal region through the openings of the Organ of Jacobson and the lachrymal duct. x 20.

FIG. 4.—A transverse section some distance behind that represented in Fig. 3. x 20.

FIG. 5.—One half of a transverse section of the nasal region of an embryo head 6 mm. in length of Eutaenia sirtalis. x 50.

FIG. 6.—A transverse section of the nasal cavity anterior to the external nasal opening. x 30.

FIG. 7.—A transverse section of the nasal cavity containing the aperture of the duct of Müller's Nasal Gland. x 30

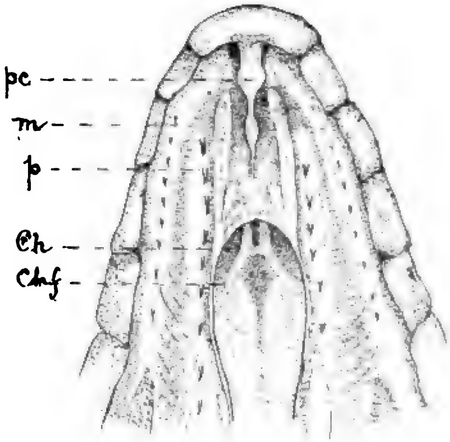
FIG. 8.—A portion of a transverse section of Organ of Jacobson in an adult Eutaenia; *J. C.* the canal of the Organ separating roof and floor; *a*, capillary vessel descending between columns, one of its branches passing to the left around the point of passage of the censory cells adjacent to superficial cells over into those of a column. Separating the columns also is seen pigmentary tissue. Above, the mucosa contains a nerve bundle cut across and a large capillary. x 250

FIG. 9.—A portion of the foregoing—*a*, superficial cells; the peripheral processes of the sensory cells pass down between them and through the "border structure"; *b*, sensory cells opposite a node (*d*) of the capillary plexus; *c*, those opposite a mesh of the same and passing over into *b'* those of the columns. (The outer ends of the sensory processes and of the superficial cells are represented diagrammatically.) x 700

FIG. 10.—A transverse section of the posterior ends of the cellular columns of the Organ of Jacobson in an embryo Entænia. The plexus separating the polygonal areas is not shown. x 200

FIG. 11.—A longitudinal (diagrammatic) section of the lachrymal duct; *a*, the basal portion found under the Organ of Jacobson and continued into *b*, ending blindly; to the walls of this latter the fused lachrymal cartilages are applied; *c*, a swelling of the lumen of the duct over the palatine bone; *d*, the portion on a level with turbinal. The gland is supposed to be seen through the eyeball.

NOTE—In the figures the shaded portions represent membrane bone, while the dotted protions are intended to designate cartillage.



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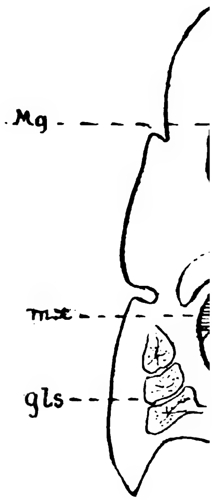

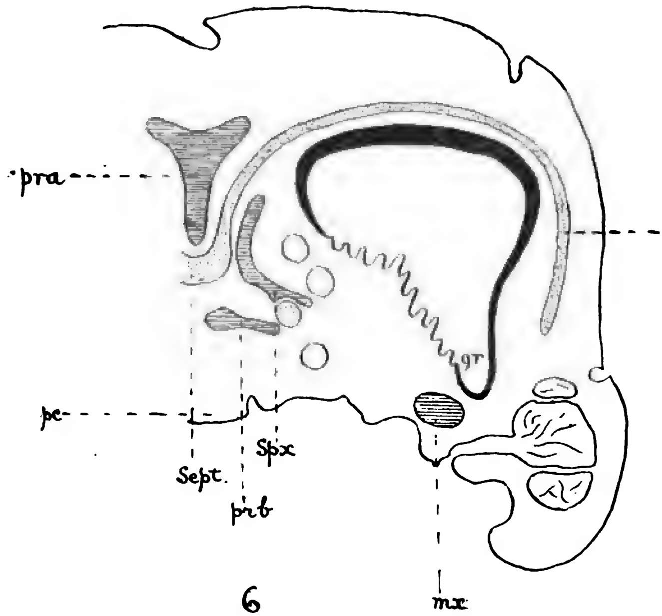

6

THE PRAIRIE CHICKEN,

OR SHARPTAILED GROUSE.

(Pedioecetes Phasianellus). (Baird).

BY ERNEST E. T. SETON.

For brevity I may describe it as a *grouse*, mottled above and white below, pretty much like all the family, but *unlike* in having the tail feathers very stiff and so short that the upper coverts ending in a point project beyond the quill feathers. Hence the name "Sharptail," or more commonly "Pintail," though throughout this country it is most known as the "Prairie Chicken."

To avoid that most tedious and thankless task, a detailed verbal description, I forward herewith a stuffed specimen, a female, but there is little difference between the sexes. The males have bright yellow bare skin over the eye (not *red*, as say Wilson and Audubon), and on each side of the neck a bare airsac, blue, and about the size of a pigeon's egg. These connect with the mouth, for they can be inflated by blowing down the throat. When the bird is quiescent they are merely sunk under the surrounding feathers, which are not in any way specially developed to hide them, as in the Ruffed and Pinnated Grouse. In the breeding season they are in a state of chronic inflation and brilliancy.

The females differ only in having their bare skin ornamentations much less (not absent, as I have seen stated). The young of both sexes are indistinguishable from the female or the male in non-breeding season, except that they are a little smaller, and have the hair-like feathers on the feet shorter and more marked with dusky.

In the feathering of the legs this grouse comes just between the Ruffed Grouse of the South and the Ptarmigan of the North, as does the bird itself geographically. The feathering stops at the base of the toes, but by reason of its length the toes are half hidden.

Their toes, as in all grouse, are notably pectinated. Not having heard of any use for these combs, I append a few observations. In

early spring they begin to drop off, just an odd one adhering here and there. In a week or two they are all gone, and during the summer the toes are clean and smooth. After the second or third week of the young one's lives, (that would be mid-August or earlier) both young and parents begin to show a row of growing scales along each toe. These grow with the growth of the chicks, and by October the birds are full grown, as are their toe combs and those of the parents. Then, since these combs exist only in winter, it is natural to suppose they are meant to act as snowshoes, and to stay the bird from slipping on the crust and icy limbs of the trees whose browse forms its winter food. These snow combs continue in perfection during the six months of winter, but with the first return of warm weather they are shed.

The tail feathers, of which I have already spoken, are worthy of notice. They are exceedingly stiff and I may say sonorous. When the male is strutting before the female, or when either is shot and dying, the tail is rapidly opened and shut, the stiff quills making a loud noise like a porcupine's quills, or like shaking a newspaper. The muscles for expanding the tail seem to be very largely developed.

The chickens winter in the dense bush, but in spring, ere yet the snow is gone, they scatter over the prairies, where alone they are found in summer. They are now very shy, for only the shy and wary ones have successfully run the gauntlet of such winter hunters as owls, foxes, wolves, martens, Indians, etc.

Their advent on the still snow-covered plains might be reckoned premature and fatal to many, but they find a good friend in the wild rose. It is abundant everywhere, and the red hips, unlike other fruit, continue to hang on the stiff stems, high above the damage of wet and earth. It grows most abundantly on the high sandy knolls, where the snow is thinnest, so here the grouse meet and are fed. In this section of the North-West stones or gravel are almost unknown, so birds requiring such for digestive purposes would be in a dilemma, but that the stones in the rose hips answer perfectly, thus the hip supplies them with both millstones and grist at once, the flesh at the same time receiving a most delicate flavor. While from the same cause the gizzard of a newly-killed grouse is of a most pleasing odor of rose.

It is difficult to over-estimate the importance of the rose to this

and other birds. I append a table of observations on the crops of grouse. I regret that it is not complete for the year :—

April	Rose hips,	birch and willow buds.
May	"	sand flowers, etc.
June	"	grass and various.
July	"	stargrass seed, etc.
August	"	grass and various berries.
September	"	" " "
October	"	grass, berries, etc.
November	"	Arbutus berries, browse, etc.
December	"	Juniper " " "
January	"	browse and equisetum tops, etc.
February and March	Not observed.	

This is, of course, a mere list of staples, the grouse being quite omnivorous, but throughout I found, that, of their food, hips formed a large part, for they are always attainable, even in winter, through their two valuable qualities, of growing where the snow is thinnest and not falling when ripe.

After the hips, their most important food, in May, is the sand-flower, which whitens the prairies with its millions, spreading from the great lakes to the Rockies. This plant is for the time the food of all creatures, the grass not yet being grown, so on it buffaloes, deer, horses, cattle, crane, grouse, geese, gophers, and all but carnivorous animals subsist. The receptacle is large and fleshy and apparently very nutritious. To the taste it is very pungent, so it may hasten the breeding season of the grouse, etc.

During spring and summer the grouse are assembled every morning on the top of some chosen hillock in companies of half-a-dozen or more. Here there is a regular performance called "Partridge Dance," the birds running about, strutting and crowing in an extraordinary manner. I refer the reader to Wilson, as his account thereof is more detailed than any I can give. I may state, however, that he says these dances terminate when all are paired, whereas I find them to continue until the young are hatched, and, indeed, I begin to have little faith in the pairing at all, as this "hillock dance" appears to be the common nuptials of the tribe, and it is difficult to see how the males and females can both be there (the males are most indefatigable in their attendance) if the males have anything to do with the eggs.

During the dance, the males strut as do most gallinaceous birds, with feathers all erect, the wings spread (not touching the ground), tail spread and upright, the head nearly touching the ground, the sacs on the neck inflated and displayed to their utmost; thus the bird runs a few yards uttering a sort of bubbling crow, which sounds as if it came from the air-sacs; after this they relax for a few moments, then repeat the performance *ad lib.* When disturbed they immediately take wing and scatter (not hide in the grass (Wilson), uttering as they rise a peculiar vibratory "cack," "cack," "cack," almost like a cough. This is nearly always uttered simultaneously with the beats of the wings, and so rarely heard except then that I at first supposed that it was caused by them, but since have heard the sound both when the bird was sailing and on the ground, besides seeing it whirr up without the note. They have also a peculiar call note, a whistle of three slurred notes. In the fall their common note is a sort of whistling grunt, which is joined in by the pack as they fly. The "crow" is heard only in spring, the grunt only in fall, but the cackle and the whistle always.

Their flight is very strong and rapid, so much so that they can in winter escape by flight from the white owl. When sprung they rise with a loud whirr, beating rapidly but soon sail, flying and sailing alternately every fifty or one hundred yards.

The hen nests in the long grass tangle, generally near cover or on the edge of timber. The nest is a slight hollow arched over by the grass, lined only with a few straws. She lays eight to sixteen eggs no larger than those of a pigeon. Just before being laid they are of a delicate sky-blue, on exposure they soon become a deep chocolate with a few dark-spots. In a fortnight they are gradually changed to a dirty white, partly by bleaching, partly by the scratching of the mother's bill in turning them. Common as addled or infertile eggs are in the barnyard, I never in nature found more than one, and that was of the present species. I found the nest in June; it had eight eggs (less than the complement); I left it untouched, and some weeks after returned to find all had hatched but one; this, on inspection, proved to be non-fertile. Assuming that they really and faithfully pair, it is accountable by supposing that the male was killed and the female laid her last egg unimpregnated and carried out her duties alone.

The young are hatched in about twenty days (?) and are covered with yellow down. From the first, like all their kind, they are strong and able to help themselves. By about the tenth day, though still weighing under two ounces, their wings are large and strong, so that when the startled mother rises with a "whirr" there are a dozen little "whirrs," and away she flies followed seemingly by a flock of sparrows, but they are only her young, still clothed in the yellow down all except the wings which shew the long strong quills of flight. When half grown they are readily mistaken for young turkeys. At about two months they are full grown but still with the mother. At this time the family generally numbers from four to six or eight individuals, but the average number of eggs is about twelve, so we can imagine the numbers that fall victims annually to their natural enemies. It is noticeable that all summer I never found grain in their crops, so that they cannot be injurious to standing grain; indeed, I have never seen them in it. But now that the young are grown, they find their way to the stacks so regularly and pertinaciously that they form a considerable item in the autumn dietary of the farmer, while they can only damage the grain that is exposed on the very top. They continue on the plains and about the farms until the first fall of snow, which immediately sets them *en masse* to the timber. In summer they rarely perch on trees (even at night, for they sleep squatting in the grass), but now they make them their favorite stations, and live largely on the browse there gathered. This is the time for the sportsman, for they are fat and well flavored. Any small clump of birch or willow is sure to contain some dozens every morning. As the winter advances, they cease to come on the plains, their haunts then being sparsely timbered country, especially if sandy and well supplied with rose bushes. They now act more like a properly adapted tree-liver than a ground-dwelling "Tetrao," for they fly from one tree to another, and perch and walk about the branches with perfect ease, seeming to spend much more time there than on the ground. When in a tree they are not at all possessed of that feeling of security from all hunters, which makes the "Ruffed Grouse" so easy a prey to pot-hunters, when so situated the "Pintail" on the contrary is very shy and disposed to fly at 150 yards.

Like most wild animals, they have a foreknowledge of storms, and when some firewood hunter returning from the woods reports that

"the chickens are going into the bush," *i. e.*, leaving the open timber and going into the dense fir coverts, the hearers make ready for a severe storm.

Like most of the grouse family, this in winter spends the night in a snow-drift. Out on the plains the wind has pounded the snow into drifts of ice-like hardness, but in the bush it continues soft (this very softness affords another security to the chickens, through its causing the wolves and foxes to quit the bush for the winter though they live there by preference the rest of the year.) In the evening the chickens fly down either headlong into a drift, or run a little then dive. Each makes his own hole. They generally go down six inches or so, and then along about a foot. By morning their breath has formed a solid wall in front of them, so they invariably go out at one side. In Ontario, the non-conductive power of snow is not as likely to be manifested as here, so to illustrate: For weeks, the thermometer being at 20 below zero (F.) six inches of snow on one-quarter inch of ice kept the water beneath above 32° F. Without the snow the same ice increased in a day to a thickness of two inches. Likewise, under 10 inches of snow the ground continued unfrozen after the thermometer had for a month ranged from zero to 40 below. Thus we can readily understand that under six inches of snow and one inch of feathers the chickens do not mind even 50 below zero. The great disadvantage of the snowbed is that they are so liable to become the prey of foxes, etc., whose sagacious nostrils indicate the very spot beneath which the bird is sleeping. I am almost inclined to think that this is the only way in which a fox has a chance of securing an old chicken, so wary are they at all times. As the winter wanes it is not uncommon for the land to be visited by a fall of snowy sleet; this drives the chickens at once into the snow drifts, and as the sleet freezes it imprisons them and in this way very many perish. In the spring the melting snows leave them exposed, but they are now little else than bones and feathers. There is little else to note about the bush or winter half of their lives. By spring, many of them, by continually pulling off frozen browse, have so worn their bills that, when closed, there is a large opening right through near the end. As the winter wanes, with their numbers considerably reduced, but with the fittest ones surviving they once more spread over the prairies, at first, in flocks, but soon to scatter and enter on their duties of reproduction.

There is another heading under which to discuss the Prairie Chicken, viz., its fitness for domestication. An apparently necessary and most profitable adjunct of every farm is a stock of poultry. But my experience with four varieties of poultry goes to shew that the winter here is far too severe; late chickens are sure to die, while old ones are almost sure to be badly frost-bitten about the head the first winter, and even lose their unprotected toes and legs in the same way. Their feathers, for want of the regular dust bath, etc., become very deplorable and stick so in points and lumps that they lose half their non-conducting power. From this it is evident that the farmer wants a fowl that is without such unnecessary and delicate appendages as combs and wattles, has its legs and feet well protected from the frost, is able to stand any amount of cold, having feathers of duck-like density. The abundance of hawks renders it also desirable that the bird be inconspicuous, not bright colored or white like the common fowls. All this seems to point very clearly to the Prairie Chicken. In addition to these it has the great advantage of maturing early; in ten weeks a Prairie Chicken is full grown, while a common fowl takes thrice as long. The grouse weighs only about three pounds, yet it yields more solid meat than a five-pound chicken, and it can fatten on what the chicken will scarcely look at, having also the advantage of being able to take at one meal enough to last it all day, if necessary, such is the size of its crop. Its flesh is of a most delicate flavor, no barn-door fowl being at all to be compared with it, though this might be one of the first things to be lost in a state of domestication.

I cannot say I know it to be capable of domestication; indeed, I know one man who kept one six months, and at the end it was as wild as át first, but this was caught when full grown. Yet Audubon tamed the Pinnated grouse with little trouble, as did Wilson the quail. And I have little doubt that in a generation or two this would become manageable. The number of eggs laid would, doubtless, increase if eggs were cautiously removed, though, I confess, I found them rather jealous, for, on taking six eggs out of a nest of fourteen, the rest were deserted. These six eggs were hatched by a hen, but earlier than her own eggs, and I found the young grouse all crushed. Wilson says, all attempts to raise the young have failed probably for want of proper food. Perhaps he is right. The situa-

tion of the Prairie Chicken's nests here, together with what little I know of the mode pursued in the Old Country for raising young pheasants, induce me to believe that young Prairie Chickens could be successfully reared in a paddock, with a dry sandy soil and plenty of anthills and rose bushes. Ants and ant eggs are the best of food for these delicate creatures.

It is hardly likely that any Manitoban farmer will try to domesticate them, when they are abundant in their wild state, especially as they cannot be expected to compete with the common fowls as egg-producers. It is also extremely unlikely that they will ever be killed out, for notwithstanding the absence of respect for game laws, even in the old settled districts the chickens are as thick as ever, for there is all over a great deal of land that will never be brought under cultivation and it is exactly suited to the chickens.

Yet I think the experiment worth trying, and if any of the gentlemen of the Society have a suitable piece of ground and inclination to take the trouble, I will endeavor in the spring to find him the necessary stock to start with.

February, 1883.

BIOLOGICAL
STUDY OF THE TAP WATER
IN THE SCHOOL OF PRACTICAL SCIENCE, TORONTO.

BY GEO. ACHESON, M. A.
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The object of this paper is to give the results of investigations into the biological nature of the suspended matter in the tap-water of the School of Practical Science. No pretence is made of being exhaustive, for the work has only been carried on at intervals, and observations for any definite length of time have not been continuous. The results therefore are fragmentary, but may serve as a basis for future and more extensive research. A thoroughly systematic examination of the water should include not merely the determination of the animal and vegetable species which are to be found in it, but the physiological influence which these organisms exert, and their importance from a sanitary standpoint. This subject accordingly may be dealt with from both a morphological and a physiological point of view. It is with the first of these aspects only that the present paper is concerned. In regard however to the physiological and hygienic aspect it may be briefly observed, that the purity of water does not depend merely on the quantity of organic matters which it contains; for, if these be living vegetable growths containing chlorophyll, they have a beneficial influence on the water, by supplying oxygen to it and removing carbon dioxide, provided, of course, that their presence in large quantities does not counterbalance their salutary effects. On the other hand, there are organisms which, even if present only in small numbers, exert a very prejudicial influence, and which, if undoubtedly recognized as constantly occurring, should mark a water as unfit for use.

To obtain matter for examination two methods may be employed. One is to tie a muslin bag to the tap and allow the water to run in a slow stream for a few hours; then, taking off the bag, rinse it in a small quantity of water, which, on being allowed to settle for a

few minutes, will afford an abundant supply of sediment. The other plan is to open the tap to the full extent and allow it to run for a short time, so as to stir up whatever sediment may be in the pipe; then a tall glass cylinder is filled, and a watch-glass attached to a piece of platinum wire, by which it can be raised, is let down to the bottom of the vessel. The whole lightly covered is put aside for 24 hours to allow it to settle, and after this the water is siphoned off almost down to the watch-glass, which can then be raised without disturbing the sediment which it contains. This latter method possesses the advantage that the same quantity of water is always taken, and thus the amounts of sediment at different times can be compared; while it is almost impossible to fix a tap to run continuously at a given rate, owing mainly to variation in the pressure of the water in the pipes.

A little of the sediment obtained in either of these ways was transferred by a pipette to a slide, and examined with a Hartnack Objective No. 8 and No. 4 Eyepiece. This combination has a magnifying power quite high enough for diagnosing the most of the forms; though on one or two occasions a No. 10 Immersion was used.

The actual amount of suspended matter present in any definite quantity of the water varies very considerably, and depends upon several conditions, among which some of the most noticeable are the season of the year, the amount being greater in winter and spring than at any other time; the prevalence of stormy weather; the quarter of the city from which the water is taken; and the tap itself; for, if the water be drawn from a pipe which is seldom used, it is sure to contain more sediment than that from one in constant use, as it settles when allowed to rest for some time. There is no doubt also that organisms are often found in the mains which are not found in water taken directly from the lake. This, together with the fact that the number of individuals of some species is greater in the water of the mains than in that of the lake, may be explained on the supposition that the former habitat affords them a better food-supply, consequently they multiply more rapidly. Tne exclusion of light also seems favorable to the development of certain forms. Another marked result of these investigations has been the conclusion, that many of the forms seem to have a preference for certain times of the year, being much more abundant then than at any other

time; but the exact harvest time of each particular form has not been accurately determined, since the observations have not been sufficiently close. For the same reason, although the comparative frequency of most of the forms met with can be indicated generally, their relative abundance or scarcity at any particular time cannot be stated with any degree of accuracy.

To the foregoing general remarks is now added an enumeration of the different organic species which from time to time I have found in the tap water of the School of Practical Science, with brief notes on some of the more interesting forms, and a more detailed account of one or two which I believe to be hitherto undescribed.

DIATOMACEAE.

The Diatoms are noticed first because by far the greatest part of the sediment consists of them, and because in the number of species they greatly exceed any other group. The diagnosis of species unless one is a specialist in this department of microscopy, is not a very easy matter, especially if the literature to which one has access is not very extensive. Accordingly a slide was prepared and sent to Prof. H. L. Smith, of Hobart College, Geneva, N. Y., who kindly named the following species:—

Melosira Crotonensis, *Tabellaria fenestrata*, *Cyclotella Kutzingiana*, *Cyc. operculata*, *Cyc. astrea* (a variety of Stephanodiscus Niagarae), *Stephanodiscus Niagarae*, *Fragillaria Crotonensis*, *Frag. Gregoryana* (= Dimeregramma Grunow), *Frag. Capucina*, *Synedra radians*, *Synedra longissima*, *Synedra ulna*, *Cocconema parvulum*, *Coc. cymbiforme*, *Coc. gibbum*, *Cymbella dicephala*, *Navicula radiosa*, *Nav. carassius*, *Nav. Rheinhardtii*, *Nav. Saugerii*, *Nav. cryptocephala*, *Nitzschia lineata*, *Surirella pinnata*, *Sur. lineata*, *Cocconeis Thwaitsii*, *Coc. placentula*, *Cymatopleura (Sphinctocystis) solea*, *Pleurosigma Spencerii*, *Gomphonema tenellum*, *Gomph. acuminatum*, *Gomph. constrictum*, *Gomph. sp. ?* *Amphiprora ornata*, *Odontidium mutabile*, and *Encyonema caespitosum*.

In addition to the above the following have also been noticed:— *Tabellaria flocculosa*, *Asterionella formosa*, *Meridion constrictum*, *Actynocyclus Niagarae*, *Nitzschia sigmoidea*, *Tryblionella gracilis*, *Epithemia turgida*, *Cymatopleura (Sphinctocystis) elliptica*, *Eunotia didyma*, *Melosira varians*, and *Melosira dentata*, *n. sp.*, with characters as follows:—Filaments, slender; frustules, scarcely twice as

long as broad, divided in the centre by a double line; extremities of the cells dentate; breadth, 0·0075 mm. —0·009 mm. Fig. 1.

The two species, *Rhizosolenia Eriensis* and *R. gracilis*, are also present, the former always and the latter quite frequently. As *R. gracilis* has only lately been described by Prof. Smith, by whom it was first discovered in filterings from the Niagara River water supply at Buffalo, its characters are appended:—"Frustules small, slender, round or but slightly compressed; annuli, obsolete; body, smooth; fifteen to twenty times as long as broad; imperfectly siliceous; calyptra, conical; bristle fully as long as the body, or longer; often slightly curved, and, with the calyptra, rigidly siliceous; length, ·004″—·008″." It can be readily distinguished from *R. Eriensis* by its curved bristle, and by the absence of the markings which are so characteristic of the latter species.

It might be observed here in passing that the above are the only two fresh water species of *Rhizosolenia* as yet known, all the others being marine. The presence of these two species, together with others of genera, such as *Stephanodiscus* and *Actynocyclus*, mostly marine, would seem to point to the fact of the connection at one period of the great lakes with the ocean, and the survival of a few marine or brackish forms, which have been able to accommodate themselves to the altered conditions of their habitat.

DESMIDIACEAE.

Desmids as far as at present known are all inhabitants of fresh water, and, as stated by Wood in his "Fresh Water Algae," prefer "that which is pure and limpid." They have been found in stagnant water, but never in that actually putrid. Next to the Diatoms they are the commonest vegetable forms to be found in the filterings from our water supply, and they seem to be most plentiful in the latter part of winter and during spring. The commonest representatives of this family are several species of *Closterium*, some of which I have not been able to determine.

In every gathering are to be found considerable numbers of a form which is figured by C. M. Vorce in a paper on the "Microscopic Forms observed in the water of Lake Erie," and called by him *Clos. Venus*, but which is much smaller than the form described by Wood under this name, the diameter as a general rule being not more, and often less, than 0·0031 mm. (= 0·00015″). In shape they vary

considerably, being more or less lunately curved, semi-circular, bent into a loose spiral, or sometimes resembling very much a pair of cow's horns; extremities greatly attenuated. On one or two occasions a larger form was observed, which agreed very closely in characters with these smaller ones. The frond was lunately curved, varying to sigmoid or spiral; distance between the extremities about 30 times the breadth; upper margin very convex, lower very concave; no central inflation; tapering gradually to an acute point at the extremities; contents granular. Diam. 0·0038 mm. (= 0·000155"). Habitat, Lake Ontario, Fig. 2.

In one gathering a fine living specimen was noticed which in most of its characters seemed to approach more nearly to *Clos. parvulum, Naegl.*, than any other, though in some respects it resembled *Clos. Venus* as described by Wood. In size however it differed from both of these. The diameter was found to be 0·0186 mm. (= 0·00074"), and the length about 8 times as much. The measurements given by Rabenhorst for *Clos. parvulum* are diam. max. 0·00026"—0·00062", and length 6–8 times as much; and according to Wood the diameter of forms referred by him to this species is 0·0008". *Clos. Venus* has a diameter of 0·0004", and is 8–12 times longer than broad. The general appearance of the form was very similar to that of *Clos. parvulum* as figured by Wood, and as the actual size of any species can hardly be regarded as fixed within narrow limits, it has been referred to *Clos. parvulum.*

Another interesting form which is nearly always present approaches in some respects the description of *Clos. setaceum*, but is not accurately described in any work at my command; accordingly I propose for it the name *Clos. filiforme*, with specific characters as follows:—

Closterium filiforme, n. sp. Frond very slender, greatly elongated, each extremity being a colourless beak as long, or nearly as long, as the body; filiform, cylindrical, smooth, not lunately curved, belly not inflated, gradually attenuated towards the apices, which are rounded and slightly curved downwards; vacuoles 3–8 in each limb in a single series. Breadth 0.0062 mm- (= 0·00025"), length 0·4154 mm.—0·62 mm. (= 0·0166"—0·025"), or say 60–100 times the breadth. Habitat, Lake Ontario, Fig. 3.

Clos. Griffithsii has also been observed. Other Desmids were *Staurastrum gracile, Staur. punctulatum*, and a species of *Cosmarium*, probably *Cos. cucumis.*

Other Chlorophyllaceous Algae present were *Protococcus sp.?* *Chlorococcus sp.?* diam. of cell itself being 0·0176 mm., and of cell together with its hyaline coat 0·0264 mm. *Ankistrodesmus* (*Rhaphidium*) *falcatus*, *Scenedesmus quadricauda*, *Pediastrum sp.?* *Pediastrum Boryanum*. The forms included in this latter species vary somewhat from the description given by Rabenhorst and Archer. The coenobium is circular in outline, cells in a single stratum, arranged in three rows round a central cell (1 + 4 + 10 + 15); inner cells variable, 4–6 angled, concave at one side; peripheral cells convex on the inner side, on the outer side notched and tapering into two long subulate points. Diam. of peripheral cells 0·0065 mm. (= about $\frac{1}{4000}$").

I have also seen another species of *Pediastrum* which is not described in any work to which I have had access. The cells are in a single stratum, and in two rows round a central cell (1 + 6 + 12); inner cells polyhedral, 4–6 angled; peripheral cells pentagonal; external angle produced into a single process about as long as the diameter of the cell. Diam. of coenobium 0·0434 mm. (= 0·00173"), and of peripheral cells 0·0124 mm. (= 0·0005").

Spirogyra sp.? Sterile joints 10 times as long as broad; spiral single with 4 turns; cell wall at each end produced. Diam. 0·0124 mm. (= 0·0005"). Fertile joints not observed.

Phycochromaceae.

Belonging to the Phycochroms there were a few forms observed, viz. :—

Gleocapsa sparsa, which is probably only a zooglaea stage of Sirosiphon; *Merismopedia nova* (*sp.?*); and at least two species of *Oscillaria*, which have been referred to *Os. nigra*, *Vauch*, and *Os. chlorina*, *Kützing*, the former being quite common during the month of March, more so probably than at any other time.

Schizophytae.

Under the name Schizophytes are included all the organisms commonly known as Bacteria, together with a few parallel green forms, multiplying chiefly by transverse fission, though in some cases spores are formed. These organisms at best have but a doubtful reputation; and if Intermittent and other malarial fevers, Anthrax, Diphtheria, Septicaemia, Pyaemia, Tubercle, and other virulent contagious dis-

eases are produced directly by these forms, it is quite proper that we should be very careful that the water we drink is free from them if possible. If we look for natural water however which is absolutely free from Bacteria, probably we shall look in vain. But we must remember that all forms of Bacteria are not capable of producing disease, even if some are, or at any rate that they do not do so under ordinary circumstances, but only in particular and well-marked conditions of the organism or organ attacked by them. We must not be surprised then to find Bacteria in our water supply. I have observed even in fresh filterings all the common forms, micrococci, rod-like forms, vibrios, spiral forms, and zooglaea stages. But if the filterings be allowed to stand exposed to the air for a few hours, it is amazing how rapidly they increase in numbers, and after a day or two the whole becomes converted into one mass of Bacteria in all stages, growing at the expense of the other organisms, and eventually leaving nothing but the siliceous frustules of Diatoms, and whatever other matter like this defies their digestive power. Probably there is no place where they thrive better, and where they exist in greater numbers, than in the School of Practical Science; for they are certain to be found there in everything which is not positively destructive to them. There is no doubt then that their presence in such abundance in sediment which has been allowed to stand for some time exposed may be in great measure accounted for by germs getting into it from the atmosphere, as well as those already there multiplying.

Adopting the view held by Billroth, Nägeli, Cienkowski, Ray Lankester, and Zopf, that all the forms usually described under the generic names Micrococcus, Bacterium, Bacillus, Leptothrix, Cladothrix, Vibrio, Spirillum, Spirochaete, &c., are only development stages of Schizophytes, in opposition to that of Cohn and others, that they are distinct species without morphogenetic connection, all the forms observed have been referred to the two species, *Cladothrix dichotoma, Cohn*, and *Beggiatoa alba, Vauch.*

Concerning the first of these two Zopf remarks, that "what the common bread mould (Penicillium crustaceum) is among the aerial mould fungi, *C. dichotoma* is among the aquatic fungi, and therefore it might be quite properly denominated the 'water-fungus' ('Wasserpilz') par excellence."

There are Leptothrix forms besides the ordinary Cladothrix filaments, which, by the breaking up of the threads, produce micrococci and rod-like forms. The cocci are circular in outline, and have a diameter equalling, or at most double, that of Micrococcus prodigiosus, Cohn. In from 24 to 48 hours these micrococci develope into rod-like forms (Bacterium, Bacillus), which again give rise to Leptothrix, and by branching to Cladothrix filaments. These filaments are often rolled into a loose spiral, and these spirals give rise to Vibrios, Spirillum—and Spirochaete—forms. All the forms already mentioned may pass into a zooglaea or resting stage.

Beggiatoa alba goes through pretty much the same modifications. There are Leptothrix-like filaments of considerably larger size than those of Cladothrix dichotoma, Bacillus, Bacterium, and Micrococcus forms. Spiral forms are also developed, which however I have never seen in any of the sediment I examined, all the spiral forms noticed having been referred to Cladothrix.

In the study of these organisms it will be found of great advantage to stain them first with rose-aniline, or iodine.

Before proceeding to enumerate the species belonging to the Animal Kingdom, a form must be described which I am puzzled to know where to locate. I have only noticed it occasionally; and I am inclined to regard it as a Desmid.

The body is spheroidal, in optical section broadly oval, surrounded by a firm cytioderm ; color, bright green ; chlorophyll, disposed in two lenticular masses ; vacuoles, four ; body surrounded by 7—9 (?) stiff, colorless, more or less curved bristles (setae), coming off radially, and 3—5 times the long diameter of the body in length. Three individuals gave the following measurements :—

Diam. (1). 0·0093 mm. by 0.0124 mm.
(2). 0·01142 mm. by 0·01428 mm.
(3). 0·0121 mm. by 0·0154 mm.

Habitat, Lake Ontario. Fig. 4.

Wood describes a globular form of *Scenedesmus* with radiating bristles, to which the organism above described is possibly allied.

In addition to the foregoing species the vegetable kingdom is represented by starch grains, spores of fungi, and occasionally some remains of the higher plants, such as pollen grains, cuticle of aquatic plants, woody fibre, &c.

PROTOZOA.

The animal forms belong mostly to the Protozoa, being nearly all included in the groups Rhizopoda and Flagellate Infusoria.

Rhizopoda.—Among the Rhizopods were noticed at least two species of Amoeba—*A. proteus* and *A. radiosa*, but not very frequently; on several occasions also *Difflugia globulosa, Actinophrys sol*, and *Acanthocystis turfacea* (*sp ?*).

Flagellata—Belonging to the Flagellata Infusoria there are a few interesting forms, some of which I shall notice in detail.

Monas lens is occasionally seen, but by far the commonest species is *Dinobryon sertularia*, and a brief description of this beautiful animalcule will not be out of place. In the spring and early summer they are to be found in large numbers in every filtering, but in autumn and through the winter they are rarely met with.

In the classification adopted by W. Saville Kent, in his "Manual of the Infusoria," they are placed in the *Order Flagellata Eustomata*, and *Family Chrysomonadidae*. The characters of the order are as follows: "Animalcules possessing one or more flagelliform appendages, but no locomotive organs in the form of cilia; a distinct oral aperture or cytostome invariably developed; multiplying by longitudinal or transverse fission, or by subdivision of the whole or part of the body-substance into sporular elements;" and of the family: "Animalcules bi-flagellate, rarely mono-flagellate, social or solitary, free-swimming or adherent, naked, loricate, or immersed within a common mucilaginous matrix or zoocytium; endoplasm always containing two lateral, occasionally green, but more usually olive-brown or yellow differentiated pigment bands; one or more supplementary eye-like pigment spots frequently present," and, as far as at present known, they all inhabit fresh water.

The genus *Dinobryon* consists of animalcules with two flagella, one considerably longer than the other; attached by a contractile ligament to the bottom of a colorless horny lorica, the individual loricae being connected together so as to form a colony or compound branching polythecium; endoplasm containing two lateral green bands, and a conspicuous eye-like pigment spot situated anteriorly.

In the species *D. sertularia Ehr.* the individual loricae are perfectly hygaline and transparent, and are shaped in general like an

inverted cone, though they are seldom seen perfectly symmetrical, but usually more or less twisted and deformed, especially at the posterior end; the mouth is everted, and below this anterior rim there is a slight constriction, then a slight expansion, below which it tapers to the posterior pointed end; they are joined into colonies by the posterior end of one lorica being attached to the interior face of the rim of the one immediately below it, without any intermediate pedicle; very often the ends of two loricae are inserted into one, and this produces dichotomy. Empty loricae like this are found in large numbers, either connected or floating free during the time of the year already mentioned; but in many cases the zooid itself is to be seen attached by its delicate transparent ligament to the bottom of the lorica, and rarely exserted. In shape the zooids are elongate-oval, with the two flagella coming off quite close together from the anterior end, and on a little lip-like projection is situated the reddish eye-spot. According to Stein, the oral aperture is close beside the point of insertion of the two flagella. By the aid of these flagella they propel themselves rapidly through the water with a rolling motion, and as they sail across the field of the microscope, with their shapely loricae, oval green bodies, red eye-spots, and rapidly vibrating flagella, they present one of the most beautiful objects to be seen in the miscroscopic world. The length of the separate loricae as given by Kent is $\frac{1}{1200}''$, and of the contained zooid $\frac{1}{2000}''$; but these measurements have always been found too small. The average length of the lorica is 0·033 mm. (= 0·0013″) and of the contained zooid 0·0132 mm. — 0·0176 (= 0·000528″ — 0·0007″).

On one occasion two separate zooids were seen in one lorica, one in the usual position at the lower end, and the other just at the mouth partly extruded. This most probably was the result of fission, and the newly formed zooid had not yet secreted its protecting calyx.

The spheroidal encystments recorded by Bütschli and Stein have also been observed. They are to be seen at the mouths of otherwise empty loricae, and also floating free. They are of a yellowish-brown colour, and consist of an outer dense cuticular cyst enclosing a smaller more or less eccentric one with protoplasmic contents. No eye-spot was observable. At one point on the outer capsule there is a little conical protuberance standing out prominently from the rest

of the circumference, and on the opposite side of the inner cyst there is a similar projection. Stein figures these as occurring about the same place on both cysts, but in all that I observed they were on opposite sides, and on the outer cyst there was only one. The diameter of the outer cyst in several instances was found to be about 0.0155 mm,, and through the protuberance 0.0217 mm.; and of the inner 0.0124 mm. Figs. 5, 6.

Dinobryon stipitatum, Stein, was also present once or twice. This species differs from the one just described in the greater proportionate length of the loricae, which are trumpet-shaped, widest at the mouth, and tapering off into the acuminately pointed posterior end, being about 7 or 8 times as long as their greatest breadth. The zooids very much resemble those of *D. sertularia,* but are more elongated, and occupy the anterior half of the lorica, being attached by a thread-like ligament to its lower side wall. A large amylaceous more or less spheroidal body is situated near the posterior part of the endoplasm. The length of the lorica according to Kent is $\frac{1}{300}''$.

Two or three other species of Flagellata have also been seen, though rarely.

One, belonging to the *Choano-Flagellata, i.e.,* monads with a collar surrounding the single flagellum, I have referred to *Salpingoeca fusiformis, Kent.* Kent gives the following characters for this species: "Lorica sessile, sub-fusiform, or vase-shaped, widest centrally, tapering equally towards the two extremities, but expanding again anteriorly into a somewhat prolonged and everted neck; contained animalcule flask-shaped as in *S. amphoridium, J. Clark,* but of larger size. Length of lorica $\frac{1}{1000}''$. Hab., fresh water, solitary."

This form was seen only on one occasion, attached to a frond of Rhizosolenia Eriensis. The lorica was empty and corresponded closely with the above description. In another part of the field however I found what probably was the zooid of this species which had been set free, though it is possible that it might have been *Monosiga socialis, Kent,* with the description of which it closely agreed. The body was somewhat pyriform, widest posteriorly, with no pedicle; a single long flagellum surrounded by a collar. Length of the body 0·0062 mm. ($=\frac{1}{4000}''$), breadth 0·00465 mm. ($=\frac{8}{50000}''$).

On one occasion I got a glimpse of a colony which I think belonged to the family *Codonosigidae* of this order. Unfortunately I lost

sight of it, and never succeeded in finding any of the same kind again. It was probably a species of *Asterosiga*, in which the monads are arranged in a stellate fashion.

Another form has been doubtfully referred to the *Flagellata-Pantostomata*, family *Bikoecidae*, which includes sedentary animalcules with an anterior lip-like prominence, either solitary or in colonies, secreting separate horny loricae, mostly stalked; flagella two, one long and one short; no distinct oral aperture. In certain of its characters this form resembled *Bicosoeca lacustris, J. Clark*, and in others *Stylobryon petiolatum, Duj. sp.*, while in general appearance it was very like a large Dinobryon. I was unable to make out whether there was a distinct oral aperture or not. The individuals as far as observed were solitary, and characterized as follows:—Lorica sub-cylindrical, a little more than twice as long as its greatest breadth, with a pedicle of about equal length, widest posteriorly, slightly everted anteriorly, tapering towards and conically pointed at the posterior extremity; zooid broadly ovate, plastic, with an anterior lip-like prominence, occupying the posterior half of the lorica, to the bottom of which it is attached by a contractile thread-like ligament on which it rotates; flagella two in number, one long and one short, inserted at the base of the lip-like prominence; endoplasm containing two lateral greenish-yellow bands, and a reddish eye-spot situated anteriorly at the base of the lip-like projection; contractile vesicle single, located posteriorly. Length of the lorica 0·03141 mm. ($= \frac{1}{800}''$), and of the contained zooid 0·0171 mm. ($= \frac{17}{25000}''$). Hab., fresh water, Lake Ontario. Fig. 7.

Kent regards *Stylobryon petiolatum* as undoubtedly a compound modification of *Bicosoeca lacustris*, and possibly the form above described is a variety of the same species, considerably larger than the one described by H. James-Clark, if it is not a species of *Dinobryon*.

The *Cilio-Flagellata* are represented by a species of *Peridineum* not determined.

Infusoria Ciliata.—Belonging to the Ciliated Infusoria there is a large species of *Vorticella* frequently seen, either attached or free-swimming; *Stentor* is rare; also a few *Holotrichous* and *Hypotrichous* forms, free and encysted are to be found occasionally.

METAZOA.

The other animal forms which have been noticed are not very numerous.

VERMES.—The worms are represented by the *Nematoid Anguillula fluviatilis*, which is not very common; and by one or two species of *Rotifera* belonging to the family *Brachionidae*, in which there is a carapace and one or more eye-spots. These are *Anuraea stipitata*, and another species with the back of the carapace ornamented with facets, as well as furnished with teeth in front. A species of the genus *Brachionus* itself has also been observed.

ARTHROPODA.—The *Crustacea* are represented by at least two species, *Cyclops quadricornus* and *Daphnia pulex*, or a nearly allied form. Cyclops especially is common both in the adult and larval stages.

Belonging to the *Tardigrada* I have noticed a species of *Macrobiotus* rarely present, probably *M. Hufelandii.*

Epithelial cells, bristles of crustacea and insects and other fragments are to be found among the debris which is always present in considerable quantity, and which is generally described as "flocculent matter." It consists mainly of broken Diatom frustules, as a good deal of it remains after boiling in nitric acid, partly also of decomposed organic matter in a fine state of division, as well as a small quantity of mineral matter.

The bearing which the foregoing observations have on the question of the purity of Toronto's water supply may now be briefly alluded to. Judging from the miscroscopical examination of the suspended matter in the water, I would characterize it as one of the purest of natural waters. inasmuch as it is almost entirely free from any organisms which are either themselves directly injurious, or which, by their presence, would show that water containing them must necessarily be injurious. The great bulk of the sediment consists of vegetable matter, and that in a living condition. The animal forms are chiefly Flagellate Infusoria, which are inhabitants of fresh water, not depending for their food on dead, decaying, and poisonous matter.

The absolute amount of sediment in the water I cannot accurately state; but the chemical analyses show the amount of albuminoid ammonia to be very small (averaging ·003—·007 grains per gal.);

and I have found it necessary to run the tap a considerable time to collect any appreciable quantity.

As already stated, my investigations have been confined to the tap water in the School of Practical Science; and, while admitting that other taps in different parts of the city would probably give different results as to quantity, yet I think the quality would be found to be practically the same.

APRIL 7th, 1883.

EXPLANATION OF THE FIGURES IN PLATE.

FIG. 1.—*Melosira dentata, n. sp.*, filament of 4 frustules.

FIG. 2.—*Closterium, sp. ?*

FIG. 3.—*Clos. filiforme, n. sp.*

FIG. 4.—Unknown form—probably a Desmid.

FIGS. 5, 6.—Encysted forms of *Dinobryon sertularia, Ehr.*

FIG. 7.—Flagellate Infusorian allied to *Bicosoeca lacustris, J. Clark*, and *Stylobryon petiolatum, Duj.*; *e*, eye-spot; *cv*, contractile vacuole; *lb*, lateral bands.

INDEX.

L

M

P

S

T

W

v. 2.

Lacks t.-p., contents + index
+ fasc. 3 (p. 251-456)
articles on Acinurus catus.

Lachs p. 251 - 456.
(Page. 3

PROCEEDINGS

OF

THE CANADIAN INSTITUTE,

SESSION 1883—1884.

FIRST ORDINARY MEETING.

The First Ordinary Meeting of the Session 1883-84 was held on Saturday, November 3rd, in the Library of the Institute, the President, J. M. Buchan, M. A., in the chair.

The minutes of last meeting were read and confirmed.

The following list of exchanges, donations and purchases received from April 1st to November 3rd, 1883, was presented:

I.—DONATIONS.

1. Report of the Superintendent of the U. S. Coast and Geodetic Survey, showing the progress of the work during the fiscal year ending June, 1880.
2. The Bystander, N. S., No. 1, January, 1883, by James Bain, jun., Esq.
3. Report of the Commissioner of Agriculture for the United States, for the years 1881 and 1882.
4. Statutes of Ontario for 1883.
5. The Canadian Parliamentary Companion for 1883, by J. A. Gemmill, Esq.
6. A glacial striated stone from boulder clay, shore of Lake Erie, Kingsville, Essex Co., presented by David Boyle, Esq.
7. Annual Reports of the Commissioner of Agriculture and Public Works for the Province of Ontario. on Agriculture, and the Arts, for 1872, 1873, 1874, 1876, 1877, 1878, 1879, 1880, 1881, 1882, (10 vols.) per Professor Buckland.
8. Report of the Superintendent of Insurance for the Dominion of Canada for the year 1882; from the Superintendent of Insurance, Dominion of Canada.
9. Catalogue of the Library of the Peabody Institute of the city of Baltimore, Vol. I., containing letters A to C; from the Board of Trustees of the Peabody Institute.
10. Check List of Insects of the Dominion of Canada, compiled by the Natural History Society of Toronto; from the compilers.

11. Journal of the Anthropological Institute of Great Britain and Ireland, 11 Nos. of various volumes to complete a set; from the Anthropological Institute.
12. Report of Canadian Archives, by Douglas Brymner, Esq., Archivist, 1882; from the Department of Agriculture, Ottawa.
13. Mémoires de la Société Académique Indo-Chinoise de Paris. Four publications from the above Society.
14. The Literary Bulletin (11 Nos.) and Bibliographical Contributions (7 Nos.) of the Harvard University Library; from the Librarian.
15. Four reports of the Peabody Institute, city of Baltimore.
16. Historical collections of the Essex Institute, 12 volumes and parts, completing a set; 13 pamphlets from the same institution.
17. Proceedings of the Academy of Natural Sciences, Philadelphia, 10 parts and volumes to complete a set.
18. The Worcester Society of Antiquity, 5 Nos., completing a set.
19. The Journal of the Linnean Society, No. 70, Vol. XIII., completing a set.
20. The Journal of the Royal Dublin Society, 8 volumes and numbers to complete a set.
21. Annals of the Lyceum of Natural History, New York, 9 volumes and numbers; Transactions of the N. Y. Academy of Sciences, 7 numbers, completing sets; from the N. Y. Academy of Sciences.
22. From the Royal Geographical Society: The Journal of the Society, Vols. 47 and 48; the "Proceedings," 8 numbers, completing sets.
23. The Museum of Comparative Zoology at Harvard College, 4 numbers.
24. Proceedings of the Royal Colonial Institute, 5 volumes.
25. Leeds Philosophical and Literary Society, six Annual Reports, and seven pamphlets on various subjects.
26. Transactions of the Royal Scottish Society of Arts, 19 parts, to complete a set.
27. La Société des Ingénieurs Civils, Paris: 12 Nos. Mémoires et Compte Rendu des Travaux de la Société for 1882.
28. The Smithsonian Institute, Washington: 6 Vols. Smithsonian Contributions to Knowledge, Vols. 18—23, completing a set; 17 Vols. Smithsonian Miscellaneous Collections, Vols. 11 to 27 inclusive; 15 Vols. of Annual Reports of the Board of Regents of the Smithsonian Institution for various years.
29. Victoria Institute: Vols. 6 to 16 of the Journal of the Transactions, to complete set; sent to Messrs. Campbell & Son for transmission.
30. Institution of Civil Engineers: Vol. 57, to complete set.
31. The Canadian Entomologist, 3 Nos. to complete a set.

II.—EXCHANGES.

CANADA:

The Canadian Entomologist, Nos. 4 to 8, 1883.

Canadian Naturalist, Vol. 10, No. 8.

Bulletin of the Natural History Society of Quebec, No. 2.

The Canadian Practitioner, Nos. 5—11.

Transactions of the Literary and Historical Society of Quebec, session of 1882-83.

The Weekly Health Bulletin, issued by the Board of Health of Ontario.

The Monthly Weather Review of the Meteorological Service, Dominion of Canada, April to September, 1883.

Report of the Meteorological Service, Dominion of Canada, for the year ending December 31, 1882.

Manitoba Historical and Scientific Society, Winnipeg, Catalogue of 340 Specimens from their Collection.

Report and Collections of the Nova Scotia Historical Society for the years 1882-83.

UNITED STATES OF AMERICA:

The Journal of the Franklin Institute, Philadelphia, April to November, 8 Nos.

The American Journal of Science, April to November, 8 Nos.

Transactions of the Connecticut Academy of Arts and Sciences, 5 Vols., from the commencement in 1867, to 1882.

Proceedings of the Boston Society of Natural History, Vol. 21, Part 4, Vol. 22, Part 1.

Memoirs of the Boston Society of Natural History, Vol. 3, Nos. 6 and 7.

Science, from the commencement to No. 38.

Proceedings of the American Antiquarian Society, Vol. 2, Parts 2 and 3.

Bulletin of the Philosophical Society of Washington, Vols. 4 and 5, 1880-82.

The Pennsylvania Magazine of History and Biography, Vol. 7, Nos. 1, 2 Vol. 6, No. 4; and Vol. 3, No. 2.

Bulletin of the American Museum of Natural History, Vol. 1, Nos. 2, 3, 4, and 14th Annual Report.

Scientific Proceedings of the Ohio Mechanics' Institute, Vol. 1, No. 4, and Vol. 2, No. 2.

Worcester Society of Antiquity, No. 18, and No. 12, Part 4; No. 3, 1877; No. 12, 1880; No. 19, 1882.

Bulletin of the Museum of Comparative Zoology, Cambridge, Mass. Vol. 10, Nos. 5 and 6.

Journal of Speculative Philosophy, Vol. 17, Nos. 1 and 2.

Account of the Semi-Centennial Celebration of the City of Buffalo.

Report of the Director of the Observatory of Yale College for 1882-83.

Harvard University Bulletin, No. 26.

MEXICO:

Tomo 3, Entrega 2ª and 4ª.

ENGLAND:

Transactions of the Manchester Geological Society, Vol. 17, Parts 5, 6 and 7.

Proceedings of the Royal Geographical Society, April to October, 1883.

Journal of the Royal Microscopical Society, April to October.

Institution of Civil Engineers, Vols. 71, 72, 73.

Transactions of the Royal Scottish Society of Arts, Vol. 10, Part 5.

Journal of the Transactions of the Victoria Institute, April to October.

Journal of the Anthropological Institute, April to October, 1882.

Transactions and Proceedings of the Botanical Society of Edinburgh, session 1882-83.

Scientific Roll for 1883.

Proceedings of the Royal Colonial Institute, 1882-83.

Report and Proceedings of the Belfast Naturalists' Field Club.

Annual Report of the Leeds Philosophical and Literary Society for 1882-83,

Transactions of the Edinburgh Geological Society, 1882.

Journal of the Linnean Society.

Proceedings of the Royal Irish Academy, Nos. 9 and 10, Dec., 1882, June, 1883.

Transactions of the Royal Irish Academy, Nos. 11, 12, 13.

INDIA :

Records of the Geological Society of India, Vols. 15 and 22.

Memoirs of the Geological Survey of India, Vol. 19.

Palæontologia Indica, Series 10, Vol. 2 ; Series 14, Vols. 1 and 3.

NEW SOUTH WALES :

Report of the Department of Mines.

Minerals of New South Wales.

New South Wales in 1881.

Journal of the Royal Society of New South Wales.

NEW ZEALAND :

Transactions and Proceedings of the New Zealand Institute for 1882.

FRANCE :

Mémoires de la Société Nationale, des Sciences Naturelles de Cherbourg, Vol. 23, 1881.

Bulletin de la Société Geologique de France, 1879—1883, 16 Nos.

Mémoires et Compte Rendu de la Société des Ingénieurs Civils, April to October, 1883.

SWEDEN :

Acta Universitatis Lundensis, Vols. 15, &c., 7 Vols.

GERMANY AND AUSTRIA :

Göttingen—Nachrichten von der K. Gesellschaft der Wissenschaften, Nos. 1—23, 1882.

München—Sitzungsberichte der Mathematisch-Physikalischen Classe der K. B. Akademie der Wisssenschaften zu München, Hefte 2, 3, 4, 5, Band 12, 1882.

Sitzungsberichte der Philosophischen, Philologischen und Historischen, Classe K. B. Akademie der Wissenschaften zu München, 1882, Hefte 1, 2, 3, Band 1 ; Hefte 1, 2, 3, Band 2 ; 1881, 4 and 5.

Astronomische, Magnetische und Meteorologische, Beobachtungen an der K. K. Sternwarte, for 1882-3.

Wien—Jahrbuch der K. K. Geologischen Reichsanstalt for 1882.

Verhandlungen der K. K. Geologischen Reichsanstalt, Nos. 12–18.

HOLLAND :

Haarlem, Archives Du Musée Teyler, Série 2, 3 Part, 1882.

Archives Neerlandaises des Sciences Exactes et Naturelles, 1882, June 17, 3, 4 and 5 Pts. : 1883, June 18, 1 Pt.

COPENHAGEN :

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Bulletin for 1882, No. 2.

III.—PURCHASES.

Life of Sir William Logan, by Harrington.

The Canadian Naturalist and Geologist. Vols. 1, 5 and 7 to complete sets.

The Journal of Speculative Philosophy, Nos. 1, 2 and 3, Vol. 10; No. 3, Vol. 11; Nos. 1, 2 and 3, Vol. 12; No. 1, Vol. 13; No. 3, Vol. 14.

The Bystander, Nos. 2, 3 and 4.

The American Journal of Science; 31 numbers to complete set.

And the various Periodicals mentioned in the last Annual Report, from April to November, 1883.

The President then delivered his Inaugural Address on

COMPLEXION, CLIMATE AND RACE.

MEMBERS OF THE CANADIAN INSTITUTE, LADIES AND GENTLEMEN:

I appear before you this evening to read the introductory paper of the session, but before doing so I wish to express my sense of the honour which my fellow members have conferred upon me by electing me a second time to the high office of President of the Canadian Institute. I wish likewise to acknowledge the heartiness of the aid and support which they gave to the Institute during last session, and to express the hope that the same unselfish and disinterested feelings which have hitherto prompted them to encourage what is done here for the advancement of science and the diffusion of knowledge may continue to operate in their breasts. The increase in membership, and the general success of the Institute during last winter, give rise in my mind, to good auguries for its prosperity during the session which commences to-night. Though the Council was unable during last session to accomplish everything that could have been wished, I think all will agree that it effected a great deal; and I confidently anticipate that much of the work which is not yet finished will be overtaken before next May. The labour of putting our library and collections in order has proved much more serious than was anticipated, but a very large part of the work has been done, and our active and efficient Assistant-Secretary, Mr. Young, has already put them so far into shape, that he is now in a position to say what we do, and do not possess, in most departments. I may add that the number of periodicals which we take, and that of societies with which we exchange publications have been considerably increased, and that, in

consequence, our facilities for affording the student of any special branch of knowledge an acquaintance with what the rest of the world is doing in it, are much improved. It may also be stated, that arrangements have been made whereby it is expected that a fuller and more regular printed report of our proceedings will be given to our members.

It seems to me that it would be inappropriate not to say a word on this occasion about the results that have flowed from a proposal made by Mr Sandford Fleming in a communication read before the Institute two or three years ago. I refer to the proposal to adopt certain meridians as standards of time—a proposal which is to take practical effect during the present month over a great part of this continent. The members of the Institute, seeing that they have in their corporate capacity twice memoralized the government, and taken other action in this matter, and in their separate capacities have seconded Mr. Fleming whenever they have had opportunity to do so, cannot but feel pleased that so much has been accomplished; and while I give utterance to that feeling of pleasure, I am sure that I am also speaking the mind of the Institute, when I express the hope, that this partial adoption of Mr. Fleming's scheme on this continent, may be but the prelude to its adoption in its entirety throughout the world.

Some years ago I had the honour to communicate to the Institute the general views at which I had then arrived in regard to the very difficult subject of the relations of complexion and climate. Though I cannot pretend that the partial solution which I then offered, was, even as far as it went, entirely satisfactory, I still think that it embodied an element of truth. Since that time, I have gained, if not increased light, at least additional information, and it has occurred to me that a new paper on the subject, written, not so much with the object of advancing any special views which I may hold, as with that of pointing out the nature of the difficulties which crop up when one attempts to elucidate it, and the character of the questions, with the solution of which its elucidation is connected, might prove to be of some popular interest.

This topic belongs to the domain of Anthropology, a science which has lately come into existence. The anthropologist might take for his motto that oft-quoted line of Pope's

"The proper study of mankind is man,"

but he would give it a meaning and an application which would astonish its author. Anthropology literally means, the science of man, and, if the term were construed in the full extent of its meaning, it would embrace all other sciences. It is not, however, so used, but is employed to designate the science which deals with the natural history of man. That is to say, Anthropology is a branch of Zoology. The great poet of the age of Queen Anne thought, and expressed the thought that the proper study of mankind is man, with the implication that it is his moral nature which is especially worthy of investigation ; the anthropologist of to-day, without leaving man's moral nature out of account, feels more at home in questions about the shape and size of skulls, the height, weight, and colour of different races, the character of their hair, the peculiarities of the different parts of their skeletons, the relations of languages, and the development of civilization on the earth.

There is no one of the differences which separate one tribe or nation from another more striking than that of colour. In consequence, men are often classified in popular parlance into white and coloured. Blumenbach, about a century ago, divided mankind on the basis of colour into five races : the Caucasian or white, the Mongolian or yellow, the American or red, the Malay or brown, and the Ethiopian or black ; and this classification has, in virtue of its simplicity, until recently been very generally accepted. It is, however, scientifically worthless. The so-called Red race varies in colour from chocolate brown to dark white. There are Chinese, Japanese and Coreans, which races, according to Blumenbach, are Mongolian, as white as many so-called Caucasians ; and the Zulus of Southern Africa, though ranked as Ethiopians, present examples of every variety of complexion from yellow to black.

In place of Blumenbach's system a great number of classifications have been offered. These may be divided into those based on language, and those based on physical peculiarities. Both are alike unsatisfactory ; the former because they often bring together tribes and nations of very different appearance ; the latter because they separate races having related languages, and connect races whose languages are extremely different. In the Indo-European family, which is a division with a linguistic basis, are included the bronze-coloured Hindoo and the blonde Scandinavian. Among the Xanthochroi, or blonde whites of Huxley, a race set apart on the basis of its

physical characteristics, are included the Mingrelians of Circassia, the Scandinavians, and the Finns, three races speaking radically unlike languages, while the Samoyedes, whose language is related to that of the Finns, and the Persians and Hindoos whose tongues resemble that of the Scandinavians, are relegated to other classes.

From facts which have occurred, and facts which we may see daily occurring in this country and the neighboring republic, we are led to the conclusion that the language a man speaks is not good evidence as to his descent. The descendants of the Dutch settlers of New York speak English. The Negroes of the South speak either English or French. On the other hand physical peculiarities change very slowly, if at all. The Spaniard of South America, the Englishman of Virginia, the Frenchman of Quebec seem to be precisely the same physically as the Spaniard of Spain, the Englishman of England, and the Frenchman of France. If the white race darkens within the tropics, or the Negro blanches under the influence of frost, the process is very slow. It would therefore seem the part of wisdom to accept a classification based on physical peculiarities. The most approved classification is that of Huxley, which is founded on the character of the hair and colour of the skin. He divides all mankind into Ulotrichi, that is, those possessing crisp or woolly hair, and Leiotrichi, or those possessing smooth hair. The colour of the former, that is, of the Ulotrichi, or the woolly-haired division of mankind, "varies from yellow-brown to the darkest hue known among men." Their "hair and eyes are normally dark, and with only a few exceptions (among the Andaman Islanders) they are dolichocephalic," that is, long-headed. "The Negroes and Bushmen of ultra-Saharal Africa, and the Negritos of the Malay Peninsula and Archipelago and of the Papuan Islands are the members of this Negroid stock."

The Leiotrichi, that is, the smooth-haired division of mankind, are divisible into four groups, typified respectively by the Australians, the Chinese, the Swedes, and the Spaniards.

1. The first of these, namely the Australioid group, have dark skins, dark eyes, "wavy black hair, and eminently long skulls with well developed brow ridges, and projecting jaws." This group includes the native Australians and Tasmanians, and some races found in India in the Dekhan. Professor Huxley is inclined to consider the ancient Egyptians a modification of this type.

2. The second, or Mongoloid group, have for the most part "yellowish-brown or reddish-brown skins, and dark eyes, the hair being long, black and straight." Their skulls range between the extremes of long-headedness and broad-headedness. The group includes "the Mongol, Tibetan, Chinese, Polynesian, Esquimaux and American races."

3. The third, or Xanthochroic group, have "pale skins, blue eyes, and abundant fair hair. Their skulls, like those of the Mongoloid group, range between the extremes" of long and broad-headedness. "The Slavonians, Teutons, Scandinavians and the fair Celtic-speaking people are the chief representatives" of this type, but it extends "into North Africa and Western Asia."

4. The dark whites, or Melanochroi, constitute the fourth group. They are "pale-complexioned people with dark hair and eyes, and generally long, but sometimes broad skulls." The group includes "the Iberians or Basques and 'Dark Celts' of Western Europe, and the dark-complexioned white people of the shores of the Mediterranean and of Western Asia and Persia." Professor Huxley is inclined to hold that the Melanochroi are not a distinct group, but result from a mixture of Australioids and Xanthochroi, or fair whites.

It will be noticed that this classification brings together the widely separated Negroes and Negritos, neither of which races is maritime. The Australians are likewise ranked with the Todas and some other tribes of the Dekhan, though neither branch has reached a stage of civilization that would enable it to build ships and cross seas. From what Professor Huxley says in regard to the origin of the Melanochroi, or dark whites, it seems fair to infer that he would explain these difficulties by the hypothesis of a once continuous belt of Negro population from New Guinea to Africa, and a once continuous belt of Australioid populations from Australia to Britain. As these two belts cover to a great extent the same ground, we have another difficulty which we must solve by assuming the intrusion of either the one race or the other, and either Australioid or Negro conquest.

These difficulties suggest, that possibly after all, Huxley's classification does not indicate relationship or common descent. The Negroes and Negritos may resemble each other, not because they are of the same stock, but on account of the fact that the sum total of their surroundings, or in other words, of their environment, is similar, and

produces similar effects upon those subjected to it. That is to say, the Negrito of Malacca and the Philippine Islands may resemble the Yoloff and the Bantu of Africa, because his climate and mode of life are similar. If this is not the case, it is singular, that, over the vast area in which either the Negrito or the Australian must have supplanted the other, there should be no evidence of mixture of race, no remains of a mixed race evidently sprung from the union of the two. You may say to me, that one race exterminated the other. I say that in early times it was impossible to conquer and exterminate a race over a vast area. It is hardly possible now for a very civilized to extirpate a very uncivilized race over a large tract of country. Much less was it possible then, when all the devilish enginery of modern war had not been invented, and the process of killing one's fellow was slow, and very far from sure.

We shall be still more doubtful of the value of the preceding classification as a guide to community of descent, when we notice how the shape of the skull, which one would think would be as fixed as the colour of the skin or the character of the hair, varies in all but the Australioid division. We know that abundance of good food will increase the size of many of the lower animals, and that by a process of artificial selection from among the varieties naturally produced we can change almost any character to an indefinite extent. May it not possibly be the case that the shape of the skull, and the colour of the skin, hair, and eyes and other physical characters may be the results of that natural selection which Darwin puts forward as the operative cause in originating species.

A great deal of light would be thrown on the question we have just raised, if it could be clearly shown that some physical character was either independent of, or dependent on the environment. For various reasons the character of colour seems to give greater promise of results than any other. We have a greater abundance of information in regard to it than any other, and it seems at any rate at first sight to vary according to a law.

"The colour of the skin" in the different races "varies from the very pale reddish brown of the so-called white races, through all shades of yellow and red brown to olive and chocolate, which may be so dark as to look black." That of the hair, varies from the flaxen of some northern races, to a very deep brown or bluish black. That of the eyes varies from a very light blue through different shades of blue,

or grey, or green, to a more or less dark brown. Fair hair, and blue, green, or grey eyes, are never found except in conjunction with a white skin. The yellow hair reported as seen in some countries in conjunction with a dark skin, is the result of the use of a bleaching agent. Light eyes may occur with dark hair and a fair skin, and dark eyes with a fair skin and fair hair. The great majority of mankind have dark eyes, dark hair, and a more or less dark skin, and Huxley's Xanthochroi, or the blonde whites of Northern Europe, are the race that departs farthest from the common type.

According to Professor Huxley, there must once have been somewhere an unmixed blonde white race, by mixing with which the Australioids of the Mediterranean region and Great Britain became blanched to their present hue. There is not, however, what one would think there ought to be on that theory, any country or part of a country inhabited only by blondes. Probably the country with the greatest proportion of fair whites in it, is Southern Sweden; but here there is no inconsiderable admixture of men of the dark white race. On the contrary, there are countries inhabited solely by Melanochroi or dark whites. Such for example are Persia and Northern Arabia. These facts, namely, that there is no tribe or nation of unmixed blondes, while there are some of unmixed brunette whites, would seem to indicate, that the fairness of the people in the native country of the white race, is due to climatic causes, which produce their maximum effect in those parts where there are most blondes.

At first sight nothing appears plainer than that complexion is a result of climate.

The very dark races are near the equator, the light-colored ones in the temperate zones. The explanation seems to be at least as old as Homer that darkness of skin results from the intensity of the sun's rays. In his poems the term Æthiopes, meaning burnt faces, the root of our word Ethiopian, is used to designate an African tribe. But a very slight extension of our knowledge shows that this theory does not explain the facts. Side by side in the same country, as, for example, India, we find races of differing color who, apparently, have occupied the same soil for many centuries. On the forty-fourth parallel of latitude, which runs a little north of this city, we find, in the old world, the European brunette, the blonde Circassian, and the yellow Mongol, while on this continent we have the brown reddish

or yellowish Indian. On the equator itself we have the African Negro, the brown Malay of Borneo, and the yellow Tupi of the valley of the Amazons. North of the blonde Russian is found the yellow Samoyede, south of the brown men of equatorial Sumatra and Java live the blacks of Australia, and the two darkest native races of this continent live near the mouth of the Colorado and that of the La Plata, each of which points is, speaking roughly, about thirty degrees distant from the equator.

The people of the eastern continent, south of the Tropic of Cancer, are for the most part brown or black. Divide what is north of the tropics into two halves by the seventy-fifth parallel of longitude and those to the west are white, those to the east yellow. The inhabitants of the islands of the Pacific vary from the light yellow of the Japanese to the chocolate brown of the Papuans. In America the Haidah Islanders and the aborigines of the neighboring parts of Alaska are almost white, the California and Arizona Indians are dark brown; the Tupis and Guaranis that occupy the valleys of the Orinoco and the Amazons, are yellow; the Peruvians, and the aborigines of La Plata and Patagonia, are brown. The darkest of these, the Charrnas, who lived near the mouth of the La Plata, have sometimes been described as black.

The variations within a short distance are often very striking. There is more dark hair in Wales than in England in the same latitude, but the proportions of dark eyes are reversed. In Wales, in Ireland, and in Brittany, dark hair and blue eyes are very frequently combined, and this has been supposed to be due to Celtic influence. In Ireland, according to Poesche, ninety per cent of the people have bluish-gray eyes. In Teutonic countries blue eyes are more abundant than gray; in Slavonic countries the reverse is the case. In Switzerland the people of the mountains are darker than those of the valleys. In Bavaria the inhabitants of the low-lying country, near the Danube, are the darkest. In Transcaucasia those who live near the Black Sea are blonde, those near the Caspian yellow,—between, there are dark whites. Blondes are found sporadically among a large number of the races of the Northern Hemisphere. That some of the extinct Guanches of the Canary Islands were blonde, is proved by their mummies. If we may trust the recently discovered picture of the mother of King Amenhotep IV., who reigned in Egypt, probably 1700 B.C., she was a blonde. At any rate, fair-haired and light-eyed

people occur at this day in considerable numbers among the inhabitants of the mountainous parts of the Barbary States. The Jews, almost everywhere, present specimens of the blonde and brunette types. The Ghelankis at the south end of the Caspian, the Nestorians of Persia, and the Kurds of the highlands between Turkey and Persia, are partially blonde. Many of the Turcomans who live just east of the Caspian Sea, though Turk by race and language, are blonde; while the Persians to the south and the Tadjiks to the east, though Indo-European in speech, are brunette. Some of the Indo-European tribes in Afghanistan, and on the upper Indus, afford specimens of fair-haired and blue-eyed men. In short we may say that Xanthochroi occur from the Arctic Ocean to the Sahara, and from the Atlantic to the Indus, in greater or smaller numbers, and that occasionally beyond these confines, among the Chinese or Coreans, or even the Indians of Northwest America, individuals may be met with, of pure blood, who exhibit either light eyes or fair hair. For example, the Spanish discoverers of the Thlinkeets of Alaska, expressly note the fact that some of them had blue eyes. "Eran de color blanco y habia muchos con ojos azules." They were of a white color and there were many with blue eyes, says Perez. According to the Abbé David there is to be met with in Sétchuan, one of the northwestern provinces of China, an aboriginal race with light eyes and hair often chestnut or yellowish.

During the last twenty-five years considerable quantities of statistics, relating to the colour of the hair, eyes, and skin, have been collected in various countries. In Great Britain Dr. Beddoe's figures show that the number of blondes increases as we go north; in France the fairest part of the population is in the north and north-east; in Belgium in the north; in Gallicia, a part of Poland, the people are fairer in the north. In Germany the observations made on school children show that Schleswig-Holstein, the northernmost province, is the fairest. The next fairest is not, as might be expected, the next most northerly province, East Prussia, but Pomerania, and the third in the list is Hanover. The geographical position of these provinces naturally leads to the inference that the Scandinavian Peninsula is the seat of the fairest population in the world. The blonde centre is probably somewhere in the southern half of that peninsula, as the Lapps in the north, though partly fair, are partly brunette. In every

[illegible] from this central point the proportion of [illegible] decreases, and that of [illegible] increases.

Many theories have been advanced to account for these anomalies. [illegible] If so, how is [illegible] between the tropics, and no [illegible] It has been thought that [illegible] by many facts, [illegible] It has been asserted that the [illegible] A more [illegible]

[illegible]

or *vice versa*. M. de Quatrefages has suggested that the malarial fevers of Africa have wrought this effect there, and that phthisis has been the agent in the north of Europe. It certainly is the case that the tropical regions of Africa are very unhealthy for whites, and that the Negro dies out north of the parallel of 40° in both hemispheres; but this does not show that both races might not be acclimatized by slow degrees without loss of colour. In other words, no reason has been shown for thinking that it is to the complexion, and not to some other racial peculiarity that the relative immunity from certain maladies is due.

Of these various views, I am inclined to hold that that of D'Orbigny and Schomburgh is most in accordance with the facts. Europe which is the seat of the white man is the moistest of the continents; the fairest of North American Indians live on the humid coast and islands of Southern Alaska and Northern British Columbia; where there are unbroken forest regions in South America, and therefore a comparatively moist climate, the aborigines are yellow; where prairies and droughts prevail, they are brown. As compared with Hindostan, Farther India is moist, and its inhabitants are less sombre in hue. The brown men of Sumatra, Borneo, Java, and Celebes inhabit forest-covered, and therefore comparatively humid islands, the black races of Papua and Australia roam over grass-clad plains, whose existence proves the relative dryness of the air. But neither is this hypothesis in accord with all the facts. The co-existence of races of different hues in India, and of the brown Malays, and black Negritos in the Philippines and Malacca, cannot be explained by it. The west coast of Great Britain is incomparably the damper, but yet the inhabitants of the east are decidedly the fairer.

Some portion of these, and similar facts, may be explained by supposing that certain introduced races have not become completely acclimatized. It might, for example, be held that this is the cause of the relative fairness of the higher castes in India. It might too, be held that if many thousands of years were allowed, the blonde inhabitants of Great Britain and Ireland would disappear, and be replaced by a homogeneous race of dark whites, similar to the pre-Celtic inhabitants of those islands. There is some evidence tending to support this view. In particular, I may mention Dr. Beddoe's observations on the colour of the eyes of women, from which it appears that the proportion of dark-eyed women in England is growing larger.

direction north, south, east, or west from this central point the proportion of blondes decreases, and that of brunettes increases.

Many theories have been advanced to account for these anomalies. The common explanation is that they are due to race. If so, how is it that we have no aboriginal blondes between the tropics, and no aboriginal blacks north of 35° N. L. It has been thought that civilization produces fairness; but this view is refuted by many facts, the civilized Peruvian Indians, for instance, being darker than their savage congeners on the Amazons. It has been asserted that the upper classes are fairer than the lower; but, though this is the case in Europe and India, the opposite state of things existed in the Sandwich Islands, and still exists in some parts of Africa. A mountain climate has been supposed to produce a light complexion, but the highlanders of Scotland and Switzerland are darker than the natives of the plains of the same countries. Indeed, a pretty good case could be made out for the theory that low, flat countries produce fair complexions. South America, for example, which has no aboriginal negroes, is much less raised above the level of the sea than Africa. But neither is this theory consonant with all the facts.

The explanation has been sought in differences of diet, and it has been conjectured that a superabundance of carbon in the food might lead to the deposit of some of it in the skin. Races then, that live largely upon fat or oily food ought, on this hypothesis, to be darker than others in the same latitude. But there are no facts to show that the Welsh or the Irish live more on carbonaceous food than the English or the Dutch, and yet there is a considerable difference in complexion. Dr. Livingstone thought that a moist climate produces dark skins; D'Orbigny considers it the cause of fairness. Poesche, in his work on the Aryans, seems to consider fairness to be due to the absence from the soil of the elements from which the pigment that gives the yellow, brown, or black shade to the skin is formed.

Darwin, Professor Huxley, M. de Quatrefages and others think it probable that racial distinctions owe their origin to the selective operation of the prevailing diseases of particular climates. Assuming, what is amply supported by facts, that individuals slightly diverging in different directions from the type are constantly being produced, it is obvious that if a dark or a light complexion be correlated with power to resist a particular disease or group of diseases, a white race may, by natural selection, be gradually developed from a coloured one,

or *vice versa*. M. de Quatrefages has suggested that the malarial fevers of Africa have wrought this effect there, and that phthisis has been the agent in the north of Europe. It certainly is the case that the tropical regions of Africa are very unhealthy for whites, and that the Negro dies out north of the parallel of 40° in both hemispheres; but this does not show that both races might not be acclimatized by slow degrees without loss of colour. In other words, no reason has been shown for thinking that it is to the complexion, and not to some other racial peculiarity that the relative immunity from certain maladies is due.

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Another explanation of some of these facts, that possesses a certain degree of probability, is, that difference of colour in the same country is due to mode of life. It may be maintained that the Samangs of Malaca, and the Aëtas of the Philippine Islands are darker than the other inhabitants, because the poorness of their dwellings, and their consequent practically constant exposure to sun or wind, renders it an advantage for them to be dark.

Another explanation to which I shall make reference later, is that humidity is probably not the sole climatic influence that operates.

I may say here that I do not attach importance to the direct influence of climatic conditions. It is, indeed, a matter of common observation that these produce considerable effects on the individual. Pruner-Bey, for example, states that he has noticed that "the European acclimated in Egypt acquires after some time a tawny skin, and in Abyssinia a bronzed skin; he becomes pallid on the coast of Arabia, cachectic white in Syria, clear brown in the deserts of Arabia, and ruddy in the Syrian mountains." But there is no proof that these cutaneous changes are inherited. If, however, it can be shown that a particular kind of skin is better than others for resisting the deleterious influences of a given climate, it stands to reason that those members of a race whose skins vary in the direction of this type, will, in each generation have the best chance of surviving and begetting children, and that by the continued increment of successive variations in the same direction, the skin and the climate will ultimately be brought into accord.

The skin consists of two layers: the inner, dense and fibrous, furnished with blood vessels and nerves, called the derma or true skin; the outer, horny, nerveless and bloodless, called the epidermis, cuticle, or scarf-skin. The cells which compose the latter originate in the *rete Malpighii*, its lowest part, are gradually forced outward by new cells and finally exfoliate. In some of these epidermic cells a pigment is found which varies in different races, but always contains a yellow element. The hue of the skin does not depend on this colouring matter alone, but is a compound effect resulting from the white of the dermis, the red of the blood in the minute vessels near the surface, the colour and quantity of the pigment, and the thickness of the cuticle. Where the cuticle is thick, the colour of the pigment will predominate over the other elements on account of the greater depth of pigment-cells. Where it is thin, and the colouring

matter light, the tint of the skin will be much affected by any change in the supply of blood to the capillaries at the surface of the body. This is the reason why the whites alone can turn pale and blush.

Closely related to the pigment of the skin are the colouring matters of the eye and hair. Dark-skinned people usually have black eyes and hair; fair hair and blue eyes are seldom found except in conjunction with a fair skin; and the eyes and hair of albinoes, in whom the pigment of the skin is wanting, are likewise destitute of colouring matter. The pink hue of their eyes is due to minute blood-vessels, whose colour is masked in ordinary organs by the pigment of the iris.

It is noteworthy that the colouring matters of the epidermis and the iris serve a very important purpose; they protect the tender underlying parts from the injurious effects of too much heat and light. Albinoes everywhere find it necessary to protect their skins and eyes from the action of the sun's rays. In warm countries they seldom go out except at night. There is this difference between them and other men, that long-continued exposure to the sun, which ordinarily develops a condition of the skin capable of resisting its rays, does not do so in their case. It may here be remarked that, the greater the quantity of the pigment, the less transparent will the epidermis be, and the more effective will it be as a protective agency. On the contrary, the smaller the quantity, the greater the transparency, and the less the protection.

Under certain circumstances the exposed parts of our bodies become tanned, that is to say, an increase in the colouring matter which they contain takes place. Dark whites tan brown, fair whites tan red. The change is caused by the influence of the sun or wind, and is obviously protective in its character, as the unpleasant feelings which result from the first exposure do not recur when we have become thoroughly tanned. This fact, I believe, contains the key which explains the distribution of colour among the races. The climate, or the mode of existence of most races, renders it an advantage to them to begin life more or less deeply tanned.

As an excretory organ, it is the function of the skin to discharge water, carbonic acid and urea—the first in large, the others in small quantities. Perspiration, or the excreting of water with some saline matter in solution, is effected in two ways. In the first place, sudoriparous glands, imbedded in the true skin, secrete sweat from

the blood. This is conveyed to the air by minute ducts passing through the epidermis. It is obvious that, the less transparent the outer skin, the less light and heat will be transmitted to excite these glands into activity. In the second place, there is a continual transudation of sweat from the minute vessels of the surface of the body through the epidermis at every point. The thicker or more oily the scarfskin, the less will the amount of this transudation be. If it be both thick and oily, as in many dark races, the quantity transuded will be reduced to a minimum; if it be thin and not oily, as in the fairest members of the white race, transudation will be copious.

The amount of transuded sweat depends, however, not only on the thinness of the cuticle, but also on the degree to which the air in contact with the body is saturated with moisture; for there is a limit to the quantity of vapour which the air can absorb. This limit varies with the temperature, warm air absorbing more than cold. It is also to be remarked that perspiration relieves the body of heat as well as of moisture, and that a dark skin may serve as a means of radiating heat in climates in which a large loss of moisture is a disadvantage. Such being the nature of the skin, I now proceed to inquire what kind of it will best suit particular regions. For this purpose climates may be classified as—

I. Arctic.
II. Moist temperate.
III. Dry temperate.
IV. Moist tropical.
V. Dry tropical.

1. When the skin is exposed to great cold, perspiration by transudation is accelerated. The frosty air, being raised many degrees in temperature by contact with the body, becomes very dry, and greedily drinks in its moisture. At the same time the body loses not only the heat which the air carries off, but also that which is rendered latent by the evaporation of the sweat. As a protection against the injury which a too rapid loss of perspiration and heat may inflict in an arctic climate, a thick integument is desirable. It is, I believe, the fact that arctic races have thick skins. At any rate M. de Quatrefages says that cases of dry rough skins occur most frequently among the polar tribes. This I take to be a result of the thickness of the

cuticle, just as, on the older parts of a tree, I take the roughness of the bark to be a consequence of its thickness.

But why should the eyes, skin and hair of the Polar tribes be darker than those of the blonde Europeans who live to the south of them? I suggest that it is on account of their perpetual or almost perpetual snows. It is a well-known fact that the rays of the sun reflected from the Arctic snows tan Europeans and produce snow-blindness in them. From these effects the natives enjoy, I understand, comparative immunity, which I think it fair to attribute to the colour of their skins and eyes. The hair, being anatomically a part of the skin, varies with it in colour.

II. By a moist temperate climate I mean one occurring in a temperate zone in which the air constantly contains a large amount of moisture. Humidity does not to any considerable extent depend on the amount of the annual rainfall. The annual rainfall of London is twenty and one-half inches, that of Toronto twenty-seven inches; yet the air of the former place is incomparably more humid. Countries in which the air is generally moist are distinguished from others in the same latitude by the limited range of the thermometer. This is due partly to the fact that the vapour of water cannot be so rapidly heated or cooled as air, and partly to the check which the presence of haze, mist, or cloud in the atmosphere puts upon radiation. A moist temperate climate is also warmer than others in the same latitude, for it owes its existence in every case to breezes from warm seas. Breezes from cold seas cannot produce a true humid temperate climate, because when they strike the land in summer they will be raised in temperature and rendered dry.

In humid temperate climates, since the rays of the sun, falling obliquely through a moisture-laden atmosphere, lose much of their light and heat, much pigment is not needed. The vapour-clogged air does not facilitate perspiration, therefore a thin epidermis is desirable. The combination of a thin epidermis with little pigment will give a white complexion.

The best example of a moist temperate climate is furnished by the countries lying around the North and Baltic Seas, which are apparently the native land of Huxley's Xanthochroi. The central part of this district, namely Southern Sweden, is probably the place where there are most blondes. But Great Britain, though more humid,

is less blonde than Germany Denmark and Sweden in the same latitudes, and in Great Britain and Ireland, though the humidity increases, the fairness of the population diminishes as we go west. Two explanations of this difficulty besides that of race, which last from the point of view of this paper is no explanation at all, have suggested themselves to me. One is that, as wind is a tanning agent, it may possibly be the case that Ireland is more windy than England, and England than Denmark and North Germany. But I have no facts to either bear out or overthrow this hypothesis. The second is that the fairest type of blonde is produced by the humidity caused by evaporation from fresh or nearly fresh water. A glance at the map shows that the greater part of the blonde area is low and swampy, and that the eastern and fairest part of it derives much of its vapour from the half-fresh Baltic Sea. This hypothesis is supported to some extent by the case of Mingrelia, the westernmost part of Transcaucasia, and the source whence the unspeakable Turk obtained the blonde beauties with which he used to stock his harem, the moisture of this country being derived from the half-fresh waters of the Black Sea.

III. By a dry temperate climate I mean one occurring in a temperate zone in which the atmosphere is usually dry. Countries in which this climate prevails are distinguished from others in the same latitude by the greater range of the thermometer. Their summers are hot and their winters cold. As a protection against the greater heat and brightness of the sun, a less transparent cuticle than that which serves the purpose in humid temperate regions is necessary. To prevent the too rapid withdrawal of the fluid contents of the capillaries by the dry air a thick epidermis is required. The combination of a thick cuticle with a quantity of pigment such as will satisfactorily modify the intensity of the sun's rays will produce various shades of yellow and brown.

A good example of a dry temperate climate is furnished by the prairie regions of North America. The aborigines of this district were brown with the exception of the Mandans, among whom a curious kind of albinism seems to have been astonishingly prevalent.

IV.—By a moist tropical climate, I mean one occurring in or near the torrid zone, in which there is no dry season. In such a climate vegetation will be luxuriant all the year round, and man will live in the shade of dense forests, in a steaming and enervating

atmosphere, where the temperature will be high, but will vary little. Though the rays of the sun will descend vertically upon him, yet their power will be diminished by the vapour contained in the air, and he will not need so dense a pigment to protect him as the inhabitants of other tropical regions. Add to this, that a thin epidermis will facilitate the perspiration which a moisture-laden atmosphere tends to check, and we come to the conclusion that the natives of such countries will be distinguished by comparatively fair complexions.

As an example of a moist tropical climate we may take the valley of the Amazons and point to the fact that its aborgines are lighter in colour than those of rainless Peru.

V.—On the contrary in a rainless tropical climate, or in one with a well-marked dry season, the rays of a vertical sun will continually or for considerable periods descend in all their power, and the densest pigment and the thickest scarfskin will be needed. In rainless Nubia, for example, the inhabitants, whether of Semitic, Hamitic, or Negro stock, are alike black.

The part of Africa south of the Great Desert, will exemplify the case of a tropical climate with a dry season. This immense region consists essentially of a strip of low coast land, and an immense level central depressed surface with a more or less elevated rim surrounding it. The inhabitants of the coast and the central depression are very black, those of the rim lighter in color. Dr. Livingstone attributed this to the greater humidity of the lower regions. But it is obvious from theoretical considerations that the elevated rim must be more humid than any other part of the continent. During the dry season, the sea-breezes, when they strike the coast, will be raised in temperature and consequently deposit no moisture until cooled by being forced upward when they come against some elevated land. The meterological observations of travellers show the facts to accord with this view.

There are black men in Africa, in India, and in Australia and some of the adjacent islands, because these countries all have long, pronounced dry seasons. Owing to the peculiar formation of the continent of America, its tropical regions are, for the most part, very humid, and consequently very dark natives are found within them only in Peru, which possesses a very dry climate.

An immense number of facts might be adduced in support of this theory; but there are some which it fails to explain. Nevertheless,

so great is the mass of evidence showing that humidity has been an efficient agent in producing fairness that I must hold to the belief that there is something in the views which I have just attempted to express. Yet, whatever may have been the causes which have given rise to the diversity of complexion that exists among mankind, it is clear that the colour of each race is now so fixed, that climatic influences change it very slowly. Neither the negro nor the white man on this continent has varied much in the direction of the Indian. Both white and negro have, however, been here only a few centuries. A much longer time has elapsed since the populous and frozen North sent her barbarian hordes across Rhene and the Danaw to destroy the Roman empire, but yet, wherever we have historical reasons for expecting to discover traces of German blood, we find a relatively large number of blondes. The land of the conquered countries, as a matter of course, fell into the hands of the German invaders, and from them sprang a new aristocracy. It is remarkable that, to this day, the nobility and gentry of every part of Christian Europe are exceptionally fair. The conquerors naturally settled in the greatest numbers in the most fertile parts; it is precisely in the mountains and the other comparatively infertile districts that the brunette whites are most numerous. In Switzerland, for example, there is a greater percentage of blondes in the more level parts in the centre, than in Mount Jura on the west, or the Rhaetian Alps on the east. Similar facts meet us in England and France. Wherever there is reason to believe that there has been a settlement of Germans or Scandinavians, the complexions are to this day comparatively fair. The nine centuries that have elapsed since the Northmen settled in Normandy have not made their descendants as dark as the neighbouring Bretons; nor have thirteen hundred years made the West Saxon of Somerset and Gloucester similar in complexion to the Welshman of Glamorgan and Caermarthen.

Facts like these have led many ethnologists and anthropologists to conclude, perhaps, too hastily, that colour is the least variable of all the characters that mark a race. This, if true, leads with considerable probability, to the hitherto little noticed, but most important conclusion, that the original seat of the Aryan race was in Europe, and on or near the shores of the Baltic Sea. I propose now to ask your attention while I show how this conclusion follows, and very

briefly enquire whether what is known from other sources about the Aryans is consonant with it.

It is well-known that philological investigation has established that nearly all the European, and some of the more important Asiatic languages are descended from a common source, and that these are at the same time related to each other in such an intimate manner and so widely different from all other languages, that scientific men feel justified in setting them apart in a family by themselves. To this family belong the Celtic, Teutonic, Slavonic, and Romance languages, together with the Greek, the Armenian, the Persian, the Hindi, and others. The language whence all these have sprung is the Aryan, and it follows as an almost necessary corollary, that wherever an Aryan language is now spoken, there must be some admixture, however slight, of Aryan blood. There is therefore a community of speech between all Englishmen and all Hindoos, accompanied by a community of blood between some of each race.

With the exception of the Aryans of India, the Aryan races are white, and, as the sacred books of the Hindoos represent their ancestors as an intrusive race in conflict with dark aborigines, it is fair to assume that their present colour is due to an admixture of non-Aryan blood, this postulate of course being always granted that climate has no appreciable effect upon the colour of a race that has once established for itself a separate and distinct type. But as has already been stated, there are two white races, the brunette and the blonde. These are intermingled in various proportions in almost every country in which whites are to be found. We have seen that the blondes are most numerous on the shores of the Baltic and North Seas, and that in whatever direction, whether north, south, east, or west one recedes from these shores, the proportion of brunettes increases. Now, assuming that racial peculiarities are unchanged, except by intermixture, were the original Indo-Europeans a blonde or a brunette race, or one composed like most of the modern Indo-European nations of an intermixture of the two?

The following facts seem to show that the original Indo-Europeans must have been either purely or largely blonde. There are only three Indo-European races, the Hindoos, the Persians, and the Armenians, in which no blondes occur, and these occupy countries too far south to be the original home of the race, since a variety of evidence shows that it must have been situated in a tolerably cold climate.

Among all the others blondes occur in greater or smaller proportions. In western Europe, wherever we have a large proportion of dark whites, we have a good deal of evidence to show that there has been a mixture of the Indo-Europeans with the previous occupants of the soil. In Italy there were, in historic times, Etruscans and Ligurians, one, or both of which races were non-Aryan. In England, France, and Spain the evidence is strong that supports the theory that there is still a large amount of Iberian or Basque blood in the population.

Now, if the original Aryans were blonde it is natural to look for their seat where there is to-day the largest fair-white population, that is, in the neighborhood of the Baltic and North Seas. Here, as a matter of fact, we find the Lithuanians, whose language of all living languages most closely approximates to the original Indo-European. Our Aryan ancestors were pre-eminently a cattle-rearing race, and there is a strong probability that the domestic cattle of Europe are descended from its native wild stocks. As they knew something of the sea, and apparently nothing of the camel or tiger, it does not appear probable that Eastern Turkestan was their original home. Western Turkestan, though bordering on a sea, is precluded by the infertility of its soil, and its utter unsuitability to the kind of life we know the Aryans must have led. It is probably true that the Persians and Hindoos lived together at one time in Eastern Turkestan, but that does not prove that they had not come there from some other place. Indeed, the hypothesis that Turkestan was the original seat of the Aryans, seems to have no better foundation than the belief that the west has been peopled from the east. It may be true that the first men who lived in Europe came from Asia. But that must have been at a period antecedent even to the very remote date at which the Aryan race developed its special characteristics. Within the historical period, at any rate, there have been as many advances of Europeans into Asia as of Asiatics into Europe. At the very beginning of written history we hear of a Persian invasion of European Russia in retaliation for a previous invasion of Persia by Scythians from Russia. After the Persians' failure to establish themselves in Europe, the Greeks established themselves in Asia and hellenized it more or less completely to the head waters of the Ganges. The reaction came when the Huns and Saracens penetrated to France. From the battle of Tours, in which Charles the Hammer turned back the Mohammedans, to the siege of Vienna, two hundred years ago,

the contest between the west and east went on with varying results; but since John Sobieski drove the Turks out of Austria the tide has turned. The Turk is on the eve of being driven out of Europe, half of Asia belongs to Russia and England, and European ideas and blood are everywhere changing the character of that continent. As far as history informs us, population has moved as often from the west to the east as from the east to the west.

The first opponent of the Asiatic origin of the Indo-Europeans, as far as I know, was one Schulz, who published a book on the source of the German race in 1826. The next considerable protest came from Omalius d'Halloy, who objected mainly on physiological grounds. He was followed by that eminently original thinker and suggestive writer, R. G. Latham, whose objections were philological. His argument is very clearly put in the following words:

"Where we have two branches of the same division of speech separated from each other, one of which is the larger in area and the more diversified by varieties, and the other smaller and comparatively homogeneous, the presumption is in favour of the latter being derived from the former rather than the former from the latter. To deduce the Indo-Europeans of Europe from the Indo-Europeans of Asia, in ethnology, is like deriving the reptiles of Great Britain from those of Ireland in herpetology."

Since he wrote these words his views have been adopted by a number of Germans, among whom may be mentioned Geiger, Cuno, and Benfey. The two former of these, with perhaps some excess of patriotism, place the cradle of the Indo-European race in the heart of Germany. Oscar Peschel places it in the Caucasus, but this is evidently a compromise. Poesche places it in the Rokitno Swamp in the neighbourhood of Pinsk in West Russia. There is here about the upper waters of the Dnieper an immense swampy region, which is said on the authority of a Russian traveller, Mainow, to be remarkable on account of the general lack of colour in all organic nature. Cases of albinism are very frequent, the horses are almost all gray or light yellow, the leaves of the trees are pale, and everything is dull and colourless.

My conclusions are:—

1. That the causes which in early times developed the existing differences of colour were partly or wholly climatic.

2. That two of these were distance from the equator and moistness of the air.

3. That there were other causes which have not been discovered.

4. That the colour characteristics of existing races change very slowly, if at all, under the influence of new climatic conditions.

5. That the agreement of two races in colour is no proof of community of origin.

6. That the chief, perhaps the only point of origin of the blonde race was in Northern Europe.

7. That the Indo-Europeans were largely blonde, and that their original home was near the Baltic Sea.

After the address, Prof. Ramsay Wright, of University College, exhibited some new microscope objectives, by Gundlach, of Rochester, U. S., and by Zeuss, of Jena.

SECOND ORDINARY MEETING.

The Second Ordinary Meeting of the Session 1883-1884, was held on Saturday, November 10th, in the lecture-room, the President in the chair.

The minutes of last meeting were read and confirmed.

The following gentlemen were balloted for, and duly elected members.

Alan Macdougall, C. E., F. R. S. E.; Messrs. John McAree, Harry Walker, Frederick T. Butler, James Jardine, G. H. Robinson, M.A., J. M. Clark, B.A., A. S. Johnston, B.A., T. G. Campbell, B.A., John Squair, B.A., H. R. Fairclough, B. A., J. Warren Reid, B. A., J. C. Robertson, B. A., Capt. Gamble Geddes, A. D. C.

The following donations and exchanges received since last meeting, were announced:

1. Minutes and Proceedings of the Institute of Civil Engineers, London, Vol. 74 Series 1882-'83, part 4. Brief Subject Index to Minutes and Proceedings of the Institute of Civil Engineers, vols. 59 to 74. Series 1879-80 to 1882-83.
2. Transactions and Proceedings of the New Zealand Institute for 1868, 1872, 1873, 1874. Vols. 1, 5, 6, and 7.
3. The Canadian Entomologist, vol. xx. No. 9 for September, 1883.

A paper entitled "The Literature of English-speaking Canada" was then read by C. Pelham Mulvany, M.A., M.D., T.C.D. Among the writers reviewed were Prof. Watson, Mr. Le Sueur, Mr. Grant Allen, Prof. Dawson, Mr. R. W. Phipps, Dr. Canniff, Principal Grant, Mr. Charles Dent, Mr. J. E. Collins, Mr. George Stewart, Mr. C. G. D. Roberts, "Seranus," "Espérance," and Mr. P. Thompson. In discussing the paper Mr. Geo. Murray noticed the omission of the names of Dr. Rolph, Mr. Charles Lindsay, and especially the late Mr. W. J. Rattray.

THIRD ORDINARY MEETING.

The Third Ordinary Meeting of Session 1883-84 was held on Saturday, November 17th, the President in the chair.

The minutes of last meeting were read and confirmed.

Mr. Henry P. Gisborne was elected a member.

The following exchange was announced as received since last meeting:

Proceedings of the Royal Geographical Society, N. S., Vol. V., No. 11, for November, 1883.

Mr. W. A. Douglas, B.A., then read a paper on "LAND AND LABOUR," in which a distinction was drawn between property in land and property in other things. We had adopted the system of land tenure that prevailed in Western Europe, and by this system the greater part of society were practically deprived of any right to the surface of the earth. Of two settlers in the North-West, for example, one secures a section which becomes a farm, the other a section which becomes the site of a town; after twenty years the farm sells for $30 or $50 an acre, the town site for $10,000 or $100,000 an acre. It is more than likely that the owner of the town-lot had done less toil for his reward than the farmer. There was a great distinction between trade in land and trade in other commodities. A man or a number of men take a piece of worthless rock, they subject it to smelting, rolling, etc., and

convert it into a knife or a steam-engine. Here they have added to the utility and have increased wealth. They have furnished a service. Every addition to that utility has been at the cost of muscle and brain. The owner of a piece of land that eventually becomes the site of a town can show no service for his demands. The land of the globe is in fixed quantity, while the populatiou demanding land is not fixed, but on this continent is rapidly increasing. In conclusion Mr. Douglas said: "If I have represented with any approach to truth the effects of our present system of land tenure, then the conclusion must be inevitable that we are acting with wicked recklessness in our new territories in alienating with a haste as though to retain possession would be equal to a plague or a deluge. A second conclusion is that our methods of taxation are radically wrong. Instead of taking revenue from the rewards of idleness, we are now doing everything in our power to diminish the reward of labour, and actually impose taxes as penalties to prevent the extension of that system of exchange by which labour seeks to produce its utmost by resorting to the best suited locations."

An animated discussion then followed, in which Dr. Mulvany, Mr. William Houston, Mr. George Murray, Prof. Ellis and Mr. Creelman took part.

FOURTH ORDINARY MEETING.

The Fourth Ordinary Meeting of the Session 1883-84 was held on Saturday, November 24th, the President in the chair.

The minutes of last meeting were read and confirmed.

Mr. J. E. Collins was elected a member.

The following exchanges were announced:

1. Science, vol. 2, No. 41, for November 16, 1883.
2. Monthly Weather Review for October, 1883.
3. Journal of the Anthropological Institute, vol. 13, No. 2, for November, 1883.
4. List of Members of the Anthropological Institute, corrected to November, 1883.

Mr. D. A. O'Sullivan, M A., then read a paper entitled :—

OUR FEDERAL UNION,

Of which the following are extracts :

I think I shall be within the spirit and letter of the constitution of this Institute in discussing the Federal Union of Canada, in the way I propose to myself in this paper. The science of speculative politics, in which the defects in any constitution may be discovered, and remedies proposed for their removal, is probably undesirable except in purely political societies. At all events it is not the subject here proposed for consideration. * * * I shall draw attention simply to the fundamental law of our Canadian Confederation, and confine myself to our constitutional existence as it is, and not speculate as to what it might have been, and be better than it is. * * *

To say that there has been a Federal Union in Canada—using the words in their strict sense—is in my opinion incorrect. The provinces which form that Union in Canada are not and were not sovereign states - they were not even possessed of reserved powers in legislation—they strictly were not relatively independent colonies of the Empire. The States of the Union, before their admission into the Union, were colonial possessions, and they retain to this day the reserved powers of legislation. Even they are not sovereign states, though it took a war to decide that point. They are, however, much nearer to the possession of sovereign power than the provinces of our Federation. * * *

It will be seen from an historical glance at the United States what took place in this respect. Their *quasi* sovereign states, in the year 1777, bound by a compact which was called a confederation, soon learned how useless was such a compact, which had no executive force, and out of which the members might come and go at liberty. Accordingly a convention of some ten years later met and arranged on the terms of an indissoluble union, from which, having once entered, secession was impossible without resorting to means outside of the proposed terms or constitution. Nine States came in and adopted it, and in a short time every State of the old and obsolete coufederation, every old colony of Great Britain was ranged under one flag and as one nation. * * *

In the British North American Colonies confederation has been talked of since the first year of this century. In 1800, 1814, in 1822, in 1825, in Lord Durham's time, in 1859 and in 1864, there have been projects of union. Of the conventions of this latter year in Quebec and Charlottetown, it will be sufficient to say that three Provinces undertook finally to deal with the question of a federation. These were not pretended to be sovereign in any sense and not at all in the sense in which the present Dominion may be said to be sovereign. These Provinces took all their rights as colonies in their hands and said in effect to the Mother Country, "We resign our present charters; we have agreed to a new state of things; wipe out the past, and ratify the arrangements we propose to make for the future." The old colonies then passed away, and in their place came one new colony of the Empire, with one parliament to make laws for the peace, order and good government of its people. The charter provides for the government of Canada. The new Canada was then divided up into as many Provinces as there were formerly colonies, with the same or probably the same geographical boundaries. The re-casting of the new Provinces of Canada from the aggregated former colonies of the empire is something not to be lost sight of—their *status* has been entirely altered—their powers of legislation are limited and the reserved powers taken from them—their ability to secede from the union out of the question—their rights to be considered sovereign states entirely untenable on any legal ground. The concession of legislative powers to the central government was done in a manner totally different from what was done in the United States, and it would be a confusion of language to speak of the present provinces conceding powers to any government before they possessed any themselves. The interposition of a statute like the Act of Confederation of 1867 between the old colonies and the new provinces may not appear of great moment to persons other than lawyers; but nevertheless it is as material as any document can be which regulates and governs the parties affected. It is like the partnership deed or joint stock charter of a new firm or company—it is to be looked to in the first instance—it is that which gives us such rights and privileges as we now possess; it is the law before all others, except imperial legislation, that must be regarded and obeyed. * * *

With us the Provinces were merged into the new Dominion—gave up their names and their charters, and submitted to be governed by one parliament at Ottawa. They were re-cast, re-created and formed into Provinces of the Dominion—no longer separate colonies of the empire, but constituent elements of the new larger colony. The powers given to the Provinces were enumerated powers—many of their ancient rights were gone or become obsolete, and henceforth they were new creatures, supreme in their own local rights, but having no capacity to increase their own stature by one cubit. * *

The main feature of every Federation is how far its constituent provinces approach to sovereign States. The autonomy of our Canadian provinces is perhaps the lowest in the scale of power that can be exemplified in history. The list of subjects assigned to the Central Government at Ottawa is fully more than double that assigned to the Provinces, and every unenumerated matter goes to swell the central list. And not only that, but the larger list embraces the important matters. When the autonomy of a Province is spoken of, or the home rule of a Province asserted, it must be with large qualifications. The home rule of an obedient wife to her husband is not an inappropriate comparison but like all other comparisons is not to be pursued too far. * * *

For good or for evil, so far as our written constitution goes, the people of Canada have agreed to be governed by one Parliament—to have laws made for the peace, order and good government of Canada—but for convenience sake the Provinces have the exclusive right to legislate on certain defined subjects. The legislation is kept under a species of control in the Courts, which is also exercised over Dominion legislation, and the other the veto power of the Governor General of Canada. The Lieutenant-Governor of each province is an official of the Government of Canada, and is sent to preside over the local Legislatures with certain powers over the legislation and with executive control. The subordination of the Provinces to the Dominion is provided for—at least on paper, and their whole duty is the transacting of the Local government assigned to them. The provinces are independent of each other, but are unable to enter into any engagements other than the constitution provides for them. This is far from being in the position of *quasi* independent states, and indeed inter-provincial dealings are removed much further than before the union of 1867. * * *

So much for the Legislative power. The judicial power is totally different from what obtains in England. In the main—except as to certain powers of the Supreme Court at Washington it is analogous to the judicial power in the United States. A judge in England cannot ignore a statute so long as it is on the books. It binds him—he may evade it or misinterpret it, but before the Constitution he has no power to query it. Such is not the case here or in the United States.

With us, as with them, the Constitution is the basis of legislative authority; it lies at the foundation of all law, and is a rule and commission by which both legislators and judges are to proceed. If the legislatures transgress their constitutional bounds the courts must correct them. But the judiciary has no control over legislature, and no power whatever to question its purpose or animus so long as such legislation is kept within its defined limits. The judiciary is, therefore, not a subordinate but a co-ordinate branch of the government of this country. It may keep the executive even within its authority by refusing to give the sanction of law to whatever it may do beyond it, and by holding the agents and instruments of its unlawful action to strict accountability.

A judge in a Division Court, as well as a judge in the Supreme Court, may be bound to ignore a statute, if not passed by the proper Legislature or Parliament. Every act of any of our legislatures repugnant to the Constitution is absolutely void, and cannot become law of the land. There is a presumption in favour of its validity, however, until the contrary is established.

The executive power in Canada is peculiar and merits a remark. Whilst the legislative powers of the Provinces and the Dominion are sharply defined, and whilst the judicial or administrative powers are little capable of creating a difference of opinion, it is impossible to say that the Act of 1867 is "not conflicting," or at least embarrassing in respect of the executive. In the British Constitution the sovereign is the apex of authority; the King or Queen theoretically summons the Parliament, which makes or is responsible for all the laws in the realm—appoints the judges who administer these laws, and the executive authority is vested in her. The same Queen in Canada is the same power, and summons the Parliament at Ottawa, appoints the judges as a general rule, with one trifling exception, and the executive government and authority of and over Canada is vested in her. This,

of course, applies only to the Federal Government, but from other expressions and from one express section in the same Act, several of the Provinces claim that Her Majesty is a necessary element in their Provincial Legislatures; that she is the executive in the Provincial Legislatures. These Provinces are Ontario, Quebec, Manitoba and British Columbia, and they use the same forms *mutatis mutandis* of enacting laws as are used at Ottawa or at Westminister. * * *

It is conceded that the Queen has no immediate power over Provincial Legislation, as the veto on it must come from Ottawa and not from England. When, therefore, Her Majesty passes an Act in the Provinces referred to, Her Majesty's representative at Ottawa may disallow it—a proceeding likely to endanger the well-known doctrine of principal and agent, but from which happily no serious results have yet happened. * * *

I have now called attention to the three great divisions of government—the executive, the judicial and the legislative. In the latter two of these we resemble the Constitution of the United States—in the former and as to the Dominion Parliament generally, we offer an example of a reduced copy of the British Constitution. We labour under the disadvantages of every people living under a written constitution—defined, limited and inflexible—but we have the advantages which a certain amount of definiteness always affords. We have not been an easy people to govern in the past, and it is likely that we will be no better in the future.

The inhabitants of the Dominion scattered from ocean to ocean—men of different countries and languages—different religions and races—are difficult to govern consecutively in the same way for any great length of time. Six changes we have had since Quebec fell, and our ablest men will now tell you that the next few years are going to decide largely the fate of the Dominion.

It may be impossible to keep in union elements that are ill-assorted or antagonistic, but the continued existence of Canada as a Federation will be due to the united good sense of the whole people rather than to the absence of defects of any constitution binding them together."

In the discussion which followed Mr. George Murray, Mr. William Houston, Mr. Alexander Marling, and Mr. William Anderson took part.

FIFTH ORDINARY MEETING.

The Fifth Ordinary Meeting of Session 1883-84 was held on Saturday, December 1st, 1883, the President in the chair.

The minutes of last meeting were read and confirmed.

The following exchanges were announced:

1. Proceedings of the Royal Colonial Institute, Vol 14, 1882-83.
2. Journal of the Linnean Society of London.
   Botany, Vol. 19, No. 122.
   " Vol. 20, Nos. 123 to 129.
   Zoology, Vol. 16. Nos. 95 and 96.
   " Vol. 17, Nos. 97, 98, 99, 100.
   Proceedings of the Linnean Society from November, 1880, to June, 1882.
   Lists of the Linnean Society for October, 1881, and October, 1882.
3. Science, Vol. 2, No. 42, for November 23, 1883.
4. Catalogue of Canadian Plants, Part 1, Polypetalæ, by John Macoun, M.A.
5. Minutes and Proceedings of the Institution of Civil Engineers, Vol. 57, Session 1878-79.
6. Science Record, Vol. 2, No. 1, Nov. 15, 1883.
7. Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils, September, 1883.
8. Journal of Speculative Philosophy, Vol. 17, No. 3.
9. Report of the Smithsonian Institution for 1881.
10. Schriften der Physikalisch—ökonomischen Gesellschaft, zu Königsberg, for 1882, first and second parts.

Mr. J. Herbert Mason then read a paper on "Transfer of Land." The object of the paper was to call attention to the cumbrous and expensive character of the present method of land transfer, and to urge the adoption of the so-called "Torrens System." The following members took part in the extended discussion which followed: Mr. Geo. E. Shaw, Mr. J. C. Hamilton, Mr. Geo. Murray, Mr. W. A. Douglas, Mr. D. Blain, Mr. J. A. Patterson, Mr. Jas. Bain, jun., and Mr. Oliver Howland.

THE SIXTH ORDINARY MEETING.

The Sixth Ordinary Meeting of the Session. 1883-84 was held on Saturday, December 8th, 1883. The First Vice-President, Mr. George Murray in the chair.

The minutes of last meeting were read and confirmed.

Mr. M. McLaughlin was elected a member.

The following exchanges were announced :

1. The American Journal of Science, Vol. 26, No. 156 for December, 1883.
2. Journal of the Franklin Institute for December, 1883.
3. The Canada Practitioner, December, 1883.
4. On the Osteology and Development of Syngnathus Peckianus, (Storer) by J. Playfair McMurrich.
5. Journal of the Royal Dublin Society, Vol. 2, 1858-'59.
6. Sitzungsberichte und Abhandlungen der Naturwissenschaftlichen Gesell schaft "Isis" in Dresden, Januar bis Juni.
7. Science Vol. 2, (No. 43, November 30, 1883.)
8. Constitution and By-Laws of the Chicago Historical Society, 1882-83.
9. Second Annual Report of the United States Geological Survey for 1880-'81.
10. Twelfth Annual Report of the U. S. Geological and Geographical Survey of New Territories; a Report of the Progress in the Exploration of Wyoming and Idaho for 1878 by F. C. Hayden; U. S. Geologist, Parts 1 and 2.
11. Maps and Panoramas to the above.
12. United States Geological Survey, Monograph 2; Territory History of the Grand Cañon District by Clarence C. Dutton.
13. Atlas to accompany the same.
14. Bulletin of the U. S. Geological Survey, No. 1.
15. Magazine of American History of December, 1883.
16. The Scientific Transactions of the Royal Dublin Society, Vol. 1, (Series 2), Parts 15, 16, 17, 18, 19 for January, February, August and November, 1882.
17. Scientific Proceedings of the Royal Dublin Society, Vol. 3, (N. S.), August, 1882, Part 5.
18. Verhandelingen der K. Akademie Van Wetenschappen, Twee en Twintigste Deel.
19. Verslagen en Mededeelingen der K. Akademie Van Wetenschappen, Afdeeling Natuurkunde, Tweede Reeks, 17th Deel, Parts 1, 2, 3.
20. Jaarboek Van de K. Akademie Van Wetenschappen, Amsterdam, 1881.
21. Memoirs of the Geological Survey of India, (Palæontologia Indica), Series 10, Vol. 2, Part 5.
22. Jahrbuch der K. K. Geologischen Reichsanstalt, 1883, Band 33, Numbers 1, 2, 3, January to September, 1883.
23. Oversigt over det Kongelige Danske Videnskabernes Selskabs, Forhandling og dets Medlemmers Arbejder i Aaret, 1882, No. 3, 1882, and No. 1, 1883, Kjobenhavn.
24. Mémoirés de la Société Royale des Antiquaires du Nord, Nouvelle Série, 1882-83, 1884 Copenhague.
25. 22 und 23 Berichte uber die Thätigkeit des Offenbacher Vereins für Naturkunde vom 29 April, 1880, bis 4 Mai, 1882, Offenbach a. M., 1883.
26. Tillaeg til Aarboger for Nordisk Oldkyndighed og Historie, 1881, Kjobenhavn, 1882.
27. Papers, Proceedings, and Report of the Royal Society of Tasmania, 1881.
28. Verhandlungen der K. K. Zoologisch-Botanischen Gesellschaft in Wien, 32 Band, 1882.
29. Offenes Schreiben auf Herrn Baron Osten Sacken's "Critical Review" Meiner Arbeit über die Notacanthen, Von Prof. Dr. Friedrich Brauer.

30. Sitzungsberichte der K. böhmischen Gesellschaft der Wissenschaften in Prag, 1881.
31. Jahresbericht der K. böhmischen Gesellschaft der Wissenschaften in Prag, 17 Juni, 1881, do. 10 Juni, 1882.
32. Anales del Museo Nacional de México, Tomo 3, Entrega 3, México, 1883.
33. Journal of the Royal Geological Society of Ireland, Vol. 16, Part 2, 1881-82.
34. Proceedings of the Cambridge Philosophical Society, Vol. 4, Parts 2, 3, 4, 5, 1881-82.
35. Transactions of the Cambridge Philosophical Society, Vol. 13, Part 2, 1882.
36. Abhandlungen herausgegeben von naturwissenschaftlichen Verein zu Bremen, 8 Band, 1 Heft, Bremen, 1883.
37. Mittheilungen der K. K. Geographischen Gesellschaft in Wien, 1882, 25 Band.
38. Sitzungsberichte der Naturwissenschaftlichen Gesellschaft, "Isis" in Dresden.

Jahrgang,	1868,	Nos.	1, 2, 3, 7, 8, 9, 10, 11, 12,	3 Nos.
"	1869,	"	1—12,	4 Nos.
"	1870,	"	4—12,	3 "
"	1871,	"	1—12,	4 "
"	1872,	"	1—12,	4 "
"	1873,	"	1—12,	2 "
"	1874,	"	1—12,	3 "
"	1875,	"	1—12,	2 "
"	1876,	"	1—12,	2 "
"	1877,	"	1—12,	3 "
"	1878,	"	1—12,	2 "

Mr. J. M. Clark, B. A., then read a paper entitled :—

SOME THOUGHTS ON THERMOTICS.

In the following paper it is proposed to consider in a few of their many aspects, the nature of heat, the laws of its propagation, its causes and its effects, noticing its correlation to the other forms of energy, and some more or less important applications of what we shall give some reasons for considering the true theory of heat to some of the problems of Chemistry, Geology and Meteorology. Heat being that in material bodies, which causes in us the sensation by virtue of which we call bodies hot or cold, hotter or colder, it is important at the outset to understand what that something in the physical world is. Prof. Tait, the eminent Natural Philosopher, in his valuable historical sketch of the Theories of Heat, says, that in the physical world, besides the inevitable Time and Space, there are but four elementary ideas, namely :—Matter, Force, Position and Motion. This statement seems open to very serious objection. Though time may from one point of view be regarded as one of the

conceptual elements of motion, and as such has been justly denominated the "great independent variable," yet to the physicist it cannot be regarded as by any means an elementary idea. This will be apparent if we remember the conventional measure of time universally employed. That measure shows that time is recognised, not as a primordial idea, but as a very complex conception involving motion, position and space.

Further, it seems utterly inconsistent with what is now known of the nature of force, to regard it as an elementary idea. If matter be really inert, the only rational use of the word force is to denote certain mechanical facts of motion. We may therefore for our present purposes regard space, matter, position and motion as the only elementary ideas in the physical world.

Heat consequently must be referred to these ideas or to combinations of them.

The experiments of Davy and Rumford demonstrated that heat cannot be matter, since they were able to extract an unlimited amount of heat from a limited quantity of matter, thus proving that the production of heat did not involve the consumption of matter. These experiments, together with an innumerable number of others of similar nature, show that the essential idea of heat lies in motion. But since to have motion matter must move, it is more correct to define Heat as a form of Energy than of Motion. From the fact that there is a mechanical equivalent of heat, it follows that the quantity of heat is proportional not to the quantity of motion, but to the quantity of energy. Thus Tyndall's brilliant work "Heat as a Mode of Motion," would have been more correctly and appropriately entitled, "Heat as a Form of Energy." Besides being more correct, this designation would have the important advantage of suggesting the remarkable connection of heat with light, magnetism, electricity, &c., by virtue of the Conservation of Energy, a principle, the discovery of which is perhaps the grandest reward of the scientific research of modern times.

Having then established that heat is a form of energy, it becomes necessary to consider the question—Are there two essentially different kinds of energy, kinetic and potential? If potential energy be defined (as it generally is) to be the energy of position, its existence is utterly inconsistent with the proposition that matter is inert, a proposition the truth of which lies at the foundation of Modern Physics.

Newton in one of his celebrated letters to Bentley, has justly said, "That one body may act upon another at a distance, through a vacuum without the mediation of anything else by and through which their action may be conveyed from one to another, is so great an absurdity, that no man, who has in philosophical matters, a competent faculty of thinking, can ever fall into it." From this it inevitably follows, that no body, or system of bodies can possess energy merely by virtue of its position, in other words by virtue of the distances of its parts from all other bodies. In this sense, therefore, potential energy involves a contradiction in terms.

But if we regard potential energy as a convenient name for those kinds of energy whose nature is not yet understood, the term is convenient and admissible, though liable to create considerable confusion. There are not therefore two distinct kinds of energy—energy of motion, and energy of position. The distinction can, in the nature of things, have no possible fundamental difference for its basis. But energy may be conveniently divided into two classes, namely, energy whose nature we in some measure understand—called kinetic—and energy—known on the other hand as potential—of whose nature we know comparatively little, but which we regard as dependent on position, not that this dependence is an ultimate physical fact, but because it is a secondary or conventional mark, which, in the absence of more definite knowledge, it is convenient to adopt.

Heat then, being beyond doubt, a form of energy, it is important to determine in what forms of matter the heat energy resides, whether for instance, in heated bodies, the vibrations, by virtue of which the bodies are said to be hot are vibrations of the atoms or of the molecules.

Notwithstanding the high authority of Tyndall to the contrary, there is good reason to suppose that heat properly so called, consists exclusively in molecular motion. To make out the probability of this apparently bold assertion, it is necessary to investigate the real nature of what is most erroneously called radiant heat, but which possesses no more of the characteristic qualities of heat than the motion of a hammer about to strike an anvil. Tyndall himself has conclusively proved, not only that radiant heat is not matter as is confusingly suggested by the origin of the phrase, but what is more to the point, that it is nothing more or nothing less than a wave motion of the luminiferous ether, which prevades not only all interstellar, but also intermolecular and interatomic space.

By the way, we may notice that the term luminiferous ether which is derived from its connection with the theory of light, and which does not at all suggest the varied functions which this mysterious medium is now supposed to fulfil is fast losing its appropriateness. In view of the recent advances in Molecular Science, energipherous would seem a much fitter term.

Though this name is suggested by the nature of radiant heat the coining of a new word is further justified by the views as to the nature of electricity, magnetism, &c., advanced by Maxwell, and now held by the leading investigators in that important field of knowledge.

Further, analysing light by the spectroscope, and remembering that on the undulatory theory of light, which is one of the most completely verified hypotheses of modern science, refrangibility is proportional to the wave-length, we can be certain that in any given section of the spectral band, whether in the doubtfully so-called thermal, luminous or actinic portions, we have vibrations of a determinate wave-length.

Now it is found by means of the thermopile that the luminous portion of the spectral hand has a heating effect, proving that luminous rays are also thermal rays, or that the identical rays, which falling on the optic nerve would excite the sensation of light, when allowed to strike the face of the thermopile produce the effects of heat.

This important identity is rendered probable by the fact that certain substances absorb light, the only explanation of the disappearance being that the substances are more or less heated. Leslie has shown experimentally that this heating does in fact take place.

Combining this conclusion with the property known as the transmutation of rays, a property discovered by Stokes, who succeeded in so diminishing the wave-lengths of the ultra-violet rays of the spectrum (by the interposition of thin plates of certain substances) as to render them visible, it follows that the fact of heat-producing chemical decomposition which can only be effected by an acceleration in the motions of the constituent atoms of the molecules, or in other words by interatomic forces, does not at all prove that heat consists in atomic as distinguished from molecular vibrations.

Even should Lockyer's hypothesis that in the enormously heated atmosphere of the sun the supposed elementary bodies are dis-

sociated, and their existence, as such, rendered impossible be proved, the same reasoning goes to show that the necessity of supposing the seat of the heat vibrations to lie in the elementary constituents of the molecules would not follow.

Tyndall in one of his contributions to Molecular Physics argues that since the power of absorption of a vapor depends on that of the liquid from which it has been obtained, or since the state of aggregation does not alter the relative power of absorption of bodies, the seat of absorption must lie in the atoms—not in the molecules—the relative positions of the molecules being altered, and consequently the conditions of molecular motion. To this it may be replied that the change in the intermolecular relations involved in a change in the state of aggregation of a body does not necessitate any alteration in the periods of the molecular vibrations but may merely lengthen or shorten their amplitudes.

On the other hand were the atoms the seat of the heat vibrations, such undoubted facts as that water has such profoundly different physical properties from both hydrogen and oxygen, that ozone has many times the absorbing power of oxygen, and that ammonia has about 5000 times the absorbing power of either of its constituents, hydrogen or nitrogen, would be utterly incapable of explanation. On the whole these considerations, combined with the general law that heat for the most part produces physical and not chemical effects, though molecular motion may undoubtedly be transformed into atomic motion subject to the law of the conservation of energy, seem to point irresistibly to the conclusion that heat is not only a form of energy but more particularly that it consists in molecular motions. The relation of heat to light is shown clearly by the analysis of light by means of a prism, and lies in the fact that all the undulations of the energipherous medium, if transformed into the molecular motion of bodies, or if allowed to excite the tactile nerves manifest themselves in the form of heat, while only a limited portion when allowed to strike the eye excites the optic nerve and produces the sensation of sight. In a manner which we now propose briefly to describe similar, more or less intimate, connexions have been established between heat and the other forces of nature, so that heat, light, electricity, magnetism, sound, chemical affinity, potential and mechanical energy are now generally regarded as but different forms of an unchangeable amount of indestructible energy.

There can be now no doubt that the theoretical foundation for the modern doctrine of the conservation of energy, of which the equivalence of heat and work is a particular case, was distinctly and substantially laid by the genius of Newton in his wonderful scholium to his Third Law of Motion.

In this scholium and in the commentary on it Newton not only enunciates the law of conservation of energy, so far as the state of experimental science in his day would permit, but also clearly anticipated the so-called modern principle of Vis Viva and D'Alembert's principle. No further advance of any moment seems to have been made till about 100 years later Davy and Rumford proved experimentallv the immateriality of heat. To Rumford is mainly due the credit of having rescued the question of the nature of heat from the domain of metaphysics, and of having devised several ingenious experiments, by means of which he arrived at a remarkably approximate value of the mechanical equivalent of heat. The next important names in connection with the history of the theory of heat are those of Fourier and Carnot. The calculations and conclusions of these profound mathematicians were expressed, it is true, in terms which to a certain extent involved the now exploded corpuscular theories of light and heat, but their reasoning and results were to such an extent independent of any particular theory that the elements involving the truth of these untenable hypotheses are capable of being almost entirely eliminated, leaving results which have proved of the greatest use in the development of the true theory of energy. Perhaps the most important of the many valuable contributions of Clausius to the theory of heat was his adaptation of the theorem of Carnot, so as to make it consistent with the principle of the equivalence of heat and work.

To Joule, the great English physicist, is undoubtedly due, as has been conclusively shown by Prof. Tait, the credit of having placed the grand law of the conservation of energy, of which the first main principle of the mechanical theory of heat is but a particular case, on a sure experimental foundation. By means of some of the most ingenious and refined experiments of modern times, Joule determined that 772 foot-pounds of work, if converted into heat, would raise 1 pound of water 1° F., or that to produce a quantity of heat sufficient to raise 1 kilogramme of water through 1° C. work must be consumed to the extent of 424 kilogrammetres, and thus placed

the truth of the dynamical theory of heat beyond all manner of doubt. His results have been extended by Helmholtz, Mayer, Clausius, and Thomson, till the law of conservation has been shown to govern all natural forces.

Thomson demonstrated that Faraday's discovery of the rotation of the plane of polarization of a polarized ray of light, produced by media under the influence of a powerful magnet, involved the dependence of magnetism on motion.

The extension of the principles of the conservation and transformation of energy to physiological phenomena has been largely due to Helmholz and Carpenter.

There can be no doubt that Maxwell's electro-magnetic theory of light is destined to play no unimportant part in the development of the true theory of energy. From data supplied by Weber Maxwell, found that electro-magnetic disturbances were propagated with the same velocity as light. The explanation of this he held to be that electricity like light was due to the undulatory vibrations of the medium, which is beyond question necessary for the propagation of light. Should this hypothesis be found to be a valid one, a very clear insight will be obtained into the real connexion between electricity, light, and radiant heat.

From what has preceded, it will be seen that the mysterious, all-pervading ether plays an increasingly important part in the prevailing physical theories. To such an extent is this the case that Tyndall has justly remarked that its relations to the matter of the universe must mainly occupy the investigations of future scientists. In order to form a more definite idea of the properties of this highly attenuated substance, which is yet so elastic and incompressible, that Stallo has characterised it as an adamantine solid, it is now proposed to attempt a calculation of its probable density. To accomplish this object, it is necessary to know the amount of radiant energy emitted by the sun. This determined by careful observations with the pyrheliometer, and expressed by means of Joule's mechanical equivalent of heat, amounts to 5,500,000 foot-pounds per second from every square foot of the sun's surface.

Now, the velocity of light is 186,000 miles per second. Therefore the radiant energy sent forth by the sun during any given second of time will at the end of that second be contained between two spheres, the smaller 433,000 miles, or the semi-diameter of the sun for radius,

and the larger 619,000, or 433,000 + 186,000 miles. The volume of this space is—

$$\frac{4\pi}{3}(5280)^3(10)^9\left\{(619)^3-(433)^3\right\}\text{ cub. ft.}$$

Also, the surface of the sun is $4\pi(433)^2(10)^6(5280)^2$ sq. ft. Therefore 1 cubic foot of ether is agitated by—

$$\frac{4\pi(433)^2(10)^6(5280)^2\times 5500000}{\frac{4\pi}{3}(5280)^3(10)^9\left\{(619)^3-(433)^3\right\}}$$

$$=\frac{5500000}{5280\times 279000}\text{ foot-pounds of energy.}$$

Let m represent the mass of each ether-particle, or the average mass if the ether-particles are not uniform, and n the number of such particles in a cubic foot, so that $nm = M$ will be the number of pounds of ether in a cubic foot.

Using the ordinary equation of the harmonic curve—

$$y = a\sin\left(\frac{2\pi x}{\lambda}+\alpha\right)$$

it will be seen by differentiating twice that the maximum velocity of any particle owing to any single wave is $\frac{2\pi a}{\lambda}V$, where a is the amplitude, λ the wave length and V the velocity of propagation. Hence the energy of a particle whose mass is m, under such circumstances is—

$$\frac{m}{g}\,\frac{2\pi^2a^2}{\lambda^2}V^2\text{ foot-pounds.}$$

Therefore the energy of a cubic foot of ether is—

$$\Sigma\frac{m}{g}\,\frac{2\pi^2a^2V^2}{\lambda^2}=\frac{M}{g}\,\frac{2\pi^2a^2V^2}{\lambda^2}$$

Equating these two expressions for the same quantity of energy we get as the mass of a cubic of ether

$$M=\frac{g\lambda^2}{2\pi^2a^2}\,\frac{5500000}{(186000)^2(279000)(5,280)^3}\text{ lbs.}$$

It will be seen that the only assumption involved in this calculation is that the average velocity of the ether particles may be taken to be equal to the maximum velocity in consequence of a single wave motion.

In order to arrive at a numerical result we have to find the value of $\frac{\lambda}{a}$, and of these two quantities only one λ has been experimentally determined.

However, remembering that on the undulatory theory of light a diminishes with the distance from the centre of radiation we are certainly safe in supposing that even in the region of space we are considering a cannot possibly be greater than 200λ.

It is scarcely possible that the velocity of the ether-particles can exceed 233,626,000 miles per 1″, the stupendous rate necessitated by this supposition. Substituting for $\frac{\lambda}{a}$ $\frac{1}{200}$ and multiplying the result by $(5280)^3$ we conclude that the mass of a cubic mile of ether is not less than $\frac{1}{4}\left(\frac{1}{10}\right)^{13}$ of a pound. Now a cubic mile of air (at 0° 760mm) contains $(10)^{10}$ lbs. Therefore air is not more than $4(10)^{23}$ times denser than the ether.

Using this value for the density, a sphere whose radius is the same as that of Neptune's orbit, or 276,000,000 would contain $2(10)^{12}$ lbs. of ether or a sphere whose radius is 95,000,000 miles, the distance of the earth from the sun, would contain 4,400,000 tons.

If we suppose, as reasoning from acoustical analogies there is considerable reason for doing, that a instead of being 200 times greater than λ is 5 times less, a cubic mile of ether would contain $\frac{1}{4}\left(\frac{1}{10}\right)^{7}$ lbs., or a sphere of the same dimensions as the earth would contain about 6,500 lbs.

After having made the above calculations, and in the course of a vain search for further data as to the value of $\frac{\lambda}{a}$ we found that some years ago Sir W. Thomson had attempted a similar undertaking, and by means of a somewhat different method of investigation, had arrived at the conclusion that the probable density of the ether was 25 times less than that given above.

Considering the uncertainty of the assumption as to the ratio between the amplitude and wave-length of the ethereal vibrations, the coincidence is satisfactorily close.

Although, as has been pointed out, the quantity of energy in the

universe is invariable and can neither be increased or diminished, yet by virtue of laws of which we have a particular case in Clausius' "Second Main Principle of the Mechanical Theory of Heat," the amount of what may be termed available energy is being constantly exhausted.

The truth of this, together with many very important consequences which follow from it, was first pointed out by Sir W. Thomson in a remarkably able paper on a "Universal Tendency in Nature to the Dissipation of Mechanical Energy." It is simply another method of saying that no known natural processes are perfectly reversible.

A few moments reflection will suffice to show that the main sources of energy available for man are (1) Food; (2) Fuel; (3) Water Power; (4) Wind. Of these food and fuel are of the same nature, food being utilized by means of animal machines, such as men, horses, &c., while fuel is converted into mechanical motion by means of engines of various kinds. The mechanical energy which is thus produced by means of food and fuel is evidently, for the most part, derived from the heat and light radiated from the sun. Water power and wind even more obviously obtain their energy from the same source. Solar radiation is therefore the grand source whence nearly all the energy available for man is derived.

Various theories have been advanced to account for the enormous amount of energy in the form of heat and light annually sent forth by the sun, and of which the earth intercepts a very small portion. It was, for instance, supposed by some that the sun's heat was produced by the combustion of its materials. A very few facts will show that this hypothesis is utterly untenable. The mass of the sun, estimated from the most reliable determinations of the solar parallax, has been found to be about $4(10)^{30}$ lbs. The consumption of a pound of coal is known to produce an amount of heat equivalent to 9,200,000 foot-pounds.

Combining these, we see that if the materials of the sun were supposed to be capable of producing by their combustion as much heat as equal masses of coal, an assumption eminently favorable to the hypothesis in question, the total mass of the sun would be consumed in producing a quantity of heat whose mechanical equivalent is $368(10)^{35}$ foot-pounds. In estimating the probable density of the ether, it was found that the quantity of energy radiated from the

sun was $4\pi(433)^2(10)^6(5280)^2$ 5,500,000 foot-pounds per second, or $(10)^{34}$ foot-pounds per annum. It therefore follows that if the theory of the origin of solar heat under examination were the true one, the energy of the sun would be completely exhausted in 3,680 years, while we know that the quantity of heat radiated from the sun has been practically as great as at present for millions of years. The theory of combustion or chemical combination, therefore, falls to the ground, and it is now generally supposed that the perennial fountain whence flow the vast energies of the solar system. is the potential energy of gravitation which is converted into kinetic energy by its mass moving towards the centre of inertia of the solar system, and thence into heat by a mechanism indicated by the physical constitution of the fiery ruler of the day.

The following investigation will show that this now generally accepted hypothesis predicates a cause known to be a *vera causa* amply capable of producing the results it is supposed to explain, and that therefore it is not inconsistent with the axiom that the cause must be equal to the effect.

Let ρ represent the density at distance r from the centre of a spherical mass, supposed equally dense at equal distances from the centre. The elemental mass, therefore, between the spherical surfaces whose radii are r and $r + dr$, is $\rho\, 4\pi r\, dr$.

Taking proper units of force, &c, and remembering the theorem that the attraction of a spherical shell on an internal particle vanishes, it follows that the force acting on this elemental mass is measured by the quantity—

$$\frac{4\pi\rho r\, dr \int_0^r 4\pi\rho r^2\, dr.}{r^2}$$

assuming of course the Newtonian law of gravitation. The work done by this elemental mass moving through an infinitesimal *dc*, will consequently be—

$$\frac{4\pi\rho r\, dr \int_0^r 4\pi\rho r\, dr\, dc.}{r^2}$$

Integrating with respect to *dr* we get as the total work done—

$$\int \left\{ 4\pi\rho\, dr. \int_0^r 4\pi\rho r^2\, dr. \right\} dr.$$

a formula which will be found to be of considerable use in solving certain important classes of problems.

Supposing ρ to be constantly uniform if the radius of the sphere be originally a and become $a - da$, dc will evidently be $\frac{r}{a}\,da$, and the total amount of work done on account of the contraction, will consequently be $\frac{3}{5}\,M^2 \frac{da}{a^2}$, where $M = \frac{4\pi}{3}\,\rho\, a^3$, the mass of the sphere.

Integrating this expression between the limits a and b we get as the amount of work done by a spherical mass M of radius a (supposed uniform) contracting to a uniform sphere of radius b, $\frac{3}{5}\,M^2\left(\frac{1}{b} - \frac{1}{a}\right)$.

Applying these formulæ to the case of the sun whose radius is 433,200 miles and whose mass is $4\,(10)^{30}$ lbs., the amount of work done, or in other words, the quantity of heat generated, by a contraction of 1 foot in the radius of the sun (supposed uniform) will be found to be represented by—

$$\frac{3}{5}\,\frac{16\,(10)^{60}}{(433200)^2\,(5280)^2}$$

The unit of force used here obviously is the attraction of unit mass on unit mass at unit distance; so that the attraction of the earth on unit mass at its surface would be represented by—

$$\frac{4}{33}\,(10)^{26}\,\frac{1}{(400)^2\,(5280)^2}$$

multiplied by the mass of the earth $= \frac{4}{33}\,(10)^{60}$ of these units.

Now this force will cause 1 lb. to move through $\frac{g}{2} = 16{\cdot}1$ ft. per second.

Therefore a contraction of 1 foot in the sun's radius will generate a quantity of heat equivalent to—

$$\frac{3}{5}\,\frac{16\,(10)^{60} \times 33 \times (4000)^2 \times (5280)^2 \times 16{\cdot}1}{(433200)^2 \times 4 \times (10)^{26}}$$

$= (10)^{33}$ foot-pounds.

If account were taken of the fact that the sun must become denser as its centre is approached, this quantity would be considerably larger.

Accordingly a yearly contraction of 10 feet in the sun's radius would be amply sufficient to sustain its heat at the present rate of radiation.

A decrease in the diameter of the sun of less than 20 miles would keep up the supply for over 5000 years. The most refined instruments would not be sufficiently precise to detect so small a variation.

If on the same hypothesis, the sun's radius were to become one-half what it now is, or the density of the sun eight times its present value, which would make its density about the same as that of lead, instead of—

$$\frac{3}{5} M^2 \frac{1}{(433200)^2 (5280)^2}$$

for a contraction of 1 foot, we should have

$$\frac{3}{5} M^2 \left(\frac{1}{\frac{1}{2}(433200)(5280)} - \frac{1}{(433200)\ 5280} \right)$$

i.e., about 433200 × 5280 times as much heat would be generated.

This would be sufficient to sustain the present rate of radiation for 22,000,000 years. Similarly if the mass of the sun were equally diffused throughout a sphere having a radius of 276,000,000 miles, which is the distance of Neptune from the sun, and were to contract till it became uniformly as dense as lead, heat enough would be produced to meet the present demand for 44,000,000 years. Further, if the solar mass had the same specific heat as water, and were raised to a temperature of 28,000°, it would contain a store of heat 2,000,000 times as great as the present yearly expenditure.

These figures, curious and instructive in themselves, derive considerable importance from their bearing on the problems of geological time, when taken in connection with the vast æons considered necessary by most geologists for the formation of the different strata of rocks, and with the still vaster ages claimed by biologists for the evolution of the existing and extinct forms of animal life.

The palæontological evidence for the high development and wide dispersal of organisms, at least in later palæozoic times, is complete; and to the existence of a flora and a fauna, such as that indicated even in the Cambrian formations, a mild climate is absolutely essential. Now though climate is profoundly affected by the presence of mountains and large bodies of water, and even more by winds and ocean currents, and by the quantities of the variable elements in the atmosphere, yet to maintain a mild climate the heat-giving power of the sun must have been materially as great as at present.

The heat generated by the sun in assuming its present density and conformation can not be supposed to be greater than that produced by contraction from the limits of the solar system to a homogeneous sphere of one-half its present radius.

This would make 44,000,000 years, the limiting age which can be assigned to the Cambrian formations.

We shall conclude by applying the principle that the absorptive power of a vapour is determined by that of the liquid from which it is derived, to explain the empirical law (enunciated by Mr. McGee) that any increase in annual or diurnal range is accompanied by a diminution of mean temperature. The aqueous vapour of the atmosphere, being derived from water, which has a comparatively high absorptive power, must also possess considerable power of absorption, and Tyndall has conclusively shown experimentally that such is the case. Also, the power of radiation is strictly proportional to the power of absorption, as is known both from theory and experiment, so that the aqueous vapour of the atmosphere is both a good absorbent and radiant.

Now, when the temperature is raised, not only will the aqueous vapour of the atmosphere be heated, but a larger amount of it will be formed, and as gases expand when heated, this vapour will tend to rise to the higher regions of the atmosphere, and radiate its heat into space. On the other hand, in a comparatively cold season the relatively cooled vapour tends to descend, the heated vapour from the surface of the earth ascends, and imparts its heat to cold space.

Also the amount of heat received from the sun may for our present purpose be considered as invariable from year to year, so that the two actions above mentioned show that the radiant absorbent and expansive powers of aqueous vapour combine to lessen the relative amount of heat retained by the earth, during both exceptionally high and exceptionally low temperatures, *i. e.*, during a period of large thermometric range, and consequently to diminish the mean temperature.

There may be and probably are other con-causes of this effect, but the one we have assigned is certainly a real and efficient factor in producing the apparently anomalous result in question.

In the discussion which followed the reading of Mr. Clark's paper, Mr. Geo. E. Shaw, Mr. J. G. Mowat, Dr. Jos. Workman, and Mr. J. M. Buchan took part.

SEVENTH ORDINARY MEETING.

The Seventh Ordinary Meeting of 1883-84 was held on Saturday, December 15th, the President in the chair.

The minutes of last meeting were read and confirmed.

The following gentlemen were admitted members:

Mr. R. W. Phipps, Mr. William Leslie Beale, Mr. Arthur J. Graham, John J. Cassidy, M. D.

List of donations and exchanges received since last meeting:—

1. Journal of the Franklin Institute for October, 1883.
2. Tillaeg til Aarboger for Norske.
   Oldkyndighed og Historiae, Aargang, 1879.
3. " " " 1880.
   Kjobenhavn, 1880-81.
4. Mémoires de la Société des Antiquaires du Nord, Nouvelle Série, 1881.
5. Bulletin of the Museum of Comparative Zoology at Harvard College, Vol. 11, Nos. 3 and 4.
6. Science, Vol. 2, No. 44, December 7th, 1883.
7. Appleton's Literary Bulletin, December, 1883.
8. Transactions of the Manitoba Historical and Scientific Society, Nos. 5 and 6.
   " " " " Nos. 1 and 2, 1883-4.
9. Proceedings of the Asiatic Society of Bengal, Nos. 1 to 8, January to September, 1883.
10. Journal of the Asiatic Society of Bengal, Vol. 52, Part 2, No. 1, 1883.
11. Scientific Proceedings of the Ohio Mechanics' Institute, Vol. 2, No. 3, September, 1883.
12. Waifs in Verse, by G. W. Wicksteed, Q. C., Law Clerk House of Commons of Canada, presented by the author.
13. Transactions of the Manchester Geological Society, Vol 17, Part 10, Sessions 1883-84.

Mr. T. B. Browning, M. A., then read a paper entitled, "England's Oldest Colony."

Mr. Browning opened his paper by commenting upon the indifference with which the Provinces of British North America treat each other, and proceeded to discuss the rights which the French have in that part of Newfoundland called the French Shore under the treaties of Utrecht, Paris, and subsequent arrangements. He also alluded to the Banks fishery, and stated that the French employ about 700 ships in this and the shore fishery, about 28,000 seamen, and make

an annual catch of a million quintals of codfish. The rights of the French seemed to him to be greatly detrimental to the interests of Newfoundland, made the richest part of the island practically a sealed book, and were a continual source of trouble to both England and France. He further referred to the rights which the Americans exercise under the Treaty of Washington, and showed that stringent regulations were become needful, in the interest of all, to prevent wanton destruction and depletion of the Newfoundland fisheries, upon which so great a part of the world depended for a great part of their food supply.

He next described the geographical position and geological formation of the island, its copper, coal, iron deposits, and made particular reference to currents along shore, which he stated to be the cause of the many shipwrecks which happen near Cape Race and St. Shotts. Having called attention to the city and harbour of St. Johns, the capital of the island and its principal attractions, he proceeded to discuss the foreign trade of Newfoundland, which, he said, is being drawn to the chief town more and more year by year, and which he placed at $16,000,000 annually. The land question next came under review in two branches; first, as regards the waterside premises of St. Johns which are built on leased lands, the leases of which expire in a year or two, and concerning which legislative action is contemplated in the coming session. Newfoundland has developed with her landlords a crisis similar to that with which Ontario had to deal in her clergy reserves, Quebec in her seignorial tenures, Prince Edward's Island in her proprietory rights.

Touching upon the larger question of land tenure Mr. Browning referred to the decrees of the Star Chamber 1630, to statute 10 and 11 Wm. III., and 15 Geo. III., ch. 31, as establishing communism in land. No man could own any acre of the soil, no reserves were given to the Protestant or any other church, and no power was granted to the governors to pass a title to land. This communism continued until 1820, and made the country a fishing preserve for the west country merchants. It enriched England and developed her maritime power, but impoverished the soil of Newfoundland. A geographical survey of the country into counties, townships, sections and lots is still to be made, and is needed for agricultural and lumbering purposes.

He then referred to certain manners and customs of the people, particularly to the gambols of Christmas-tide, which, long since dead in England, flourished in Newfoundland until about twenty years ago. He gave statistics showing the progress of total abstinence, and described the chief agencies in the movement as well as the lineage and religion of the inhabitants of the island. It seems that the first colony permanently settled in Newfoundland was that of John Guy, who acted as manager for a company in which Lord Bacon was a shareholder. Colonies were also formed by Lord Baltimore in 1623, and several by the French and Portuguese.

The main industries were described as the summer and spring fisheries; the first of cod, salmon and herring, the second of seals. The fish caught was valued at from ten to twelve million dollars, the number of seals reckoned at a yearly average of 600,000. The condition of the fishermen, which had been almost hopeless from the crushing weight upon them of the supply system, was improving. Education was doing something for them, facilities of communication more. Their great need was a home market, at least a market nearer than Brazil, Spain or Italy. Formerly Newfoundland's surplus wealth was drawn to the West of England, the shores of the Mersey and Clyde, but is now adorning her own capital and spreading a spirit of enterprise among her people. They look to Canada and the West rather than to Britain and the East. The question of Confederation, he said, is with Newfoundland one of terms, and may be expected to be answered in the affirmative in the near future.

In the discussion which followed Mr. J. M. Buchan, Mr. Fred. Phillips, Mr. James Bain, jun., Mr. Geo. E. Shaw, Mr. John Notman, and Mr. B. B. Hughes took part.

EIGHTH ORDINARY MEETING.

The Eighth Ordinary Meeting of the Session 1883-'84 was held on Saturday, December 22nd, 1883, the President in the chair.

The minutes of last meeting were read and confirmed.

The following gentlemen were elected members of the Institute :—

H. H. Langton, B.A., Charles Miles, C.E., S. George Curry, Architect.

The following exchanges were announced :

1. Annual Report of the Museum of Comparative Zoology at Harvard College for 1882-'83.
2. Science, Vol. 2, No. 45, December 14, 1883.
3. Monthly Weather Review for November, 1883.
4. Report of the Superintendent of the United States Coast and Geodetic Survey for the year ending June, 1881.

Mr. Alan Macdougall, C.E., F.R.S.E., read a paper entitled :—

CANADIAN CATTLE TRADE AND ABATTOIRS.

The dependence of Britain on foreign or extraneous sources for much of its food supplies has led to the formation of numerous industries all over the world, and especially on the North American Continent. For its bread-stuffs it may be said to be wholly dependent on the United States, as the quantities sent over from there entirely dwarf the receipts from European countries. Out of the amount exported to Europe, Britain receives 75 per cent. of the wheat, and 90 per cent. of the flour and corn. The wheat crop in 1880 a failure in most of the European countries was a surprisingly abundant one in the States, and it is due to this that many of these countries were saved from starvation.

As the intercourse between Britain and her colonies has increased closer trade relations have been established, and with none have these relations grown to greater bulk than with our Dominion. Our export of bread-stuffs are assuming gratifying proportions, year by year they increase, and year by year the importance of our magnificent waterways grow in like magnitude. Our exports of bread-stuffs

have increased to such proportions as to cause the St. Lawrence to be considered a formidable rival to the ports of the Eastern States. This route has opened up the way for the export of other agricultural products, among which is the important trade in cattle which has sprung up between this Province and Britain. The fattening of cattle for the British market has been carried on in our midst in such a quiet unobtrusive manner, few people are aware of the large volume of trade done in this line, or of its financial results to our Province and the Dominion.

From the last return of the Bureau of Industries for the Provinces of Ontario and Quebec, it is learned that our Province exported in the years 1871-'81 :—

Eggs, to the value of	$4,114,040
Butter "	4,240,564
Cheese "	9,277,459

If the totals given for the two Provinces be taken the exports of

Eggs were of the value of	$5,283,557
Butter "	29,625,762
Cheese "	37,243,351

It is not necessary for the present purpose to detail the amounts which went to Britain, the States and elsewhere.

The export of cattle and sheep has increased very much within the last six years, particularly to Europe. The figures to Europe, are:

YEAR.	CATTLE.	SHEEP.
1877	6,940	9,509
1878	18,655	41,225
1879	25,009	80,332
1880	50,905	81,843
1881	45,535	62,404
1882	35,738	75,905

The Shipments to Great Britain, were in

	1880.		1881.		1882.	
	CATTLE.	SHEEP.	CATTLE.	SHEEP.	CATTLE.	SHEEP.
Montreal..	35,416	67,943	32,722	39,218	28,183	65,183
Quebec..	9,894	11,208	9,212	21,809		
Halifax	5,595	2,692	3,601	1,374		

The values of horned cattle and sheep exported in 1882, were for

HORNED CATTLE.

Province.	To Britain.	To United States.	To All Countries.
Ontario..............	$ 72,972	$ 374,858	$ 449,590
Quebec..............	2,316,604	45,517	2,363,296
Dominon...........	2,706,051	423,807	3,256,330
SHEEP.			
Ontario........	$ 20,976	....	$ 491,640
Quebec.......... ..	446,755	....	606,050
Dominion............	510,152	....	1,228,957

Beef to the value of $49,798 was exported from the Dominion in 1882, of which $25,095 went to Britain.

The falling-off in the numbers of cattle in 1882 is due to the increased number exported to the States, and also to the large shipments made in the prior three years, when all the marketable cattle were sent to Britain, and thousands of beasts left this Province which ought to have been kept here.

The total returns of cattle exports in 1882 are in excess of those of other years.

The improvement in quality is becoming more marked every year by the use of Shorthorn, Hereford and Angus bulls, which must in a few years greatly increase the value of Canadian cattle. Mr. Dyke, the Dominion Agent in Liverpool writes, that our cattle can compare favourably in points of breeding and quality with those bred in the best districts of Great Britain, and that this is specially noticeable in sheep.*

In all agricultural statistics relating to the Province of Ontario, the Province of Quebec has to be joined as the ports of shipment. Montreal and Quebec are in the latter, and exports are given from that Province far in excess of its legitimate trade, and belittling to our Province. The question is taken up in the last report of the Bureau of Industries, and ably treated by the energetic head of the department. He places the proportion for Ontario at 75 per cent. of the total exports. Prior to 1876 fully 80 per cent. of our exports went to the States, since that year the returns show a considerable increase in the shipments to Great Britain.

The total value of agricultural products sent to Great Britain from the two Provinces during the years 1871-'81 amount to the

* Sessional Papers Dom. Can. 1883, App. XIV., p. 199, *et seq.*

magnificent sum of $175,042,730, and to all countries to $325,919,720.

In the dead meat trade the largest returns are made from the Province of Nova Scotia; this may be due to shipments of dressed beef and mutton being made in winter when carcases are frozen by natural means, and are in a condition to bear a long railway journey and several handlings with impunity, whilst the shipment of live animals is confined to the warmer portions of the year when navigation is open.

The Dominion does not appear to have entered so largely into this branch as the States, from which the supply has decreased considerably in the last two or three years. It is affirmed by some authorities that there was not a sufficiently large margin to encourage a continuance, when Australian meat was being imported so successfully; whilst others declare that home consumption has increased, chiefly in the west and north-west through the large immigration of the last two years, and consequently the demand was equalling the supply.

It may not be out of place to mention that in some British cities, Canadian dairy produce is much belittled, whatever is good in butter or cheese is called "American," and what is bad American is too often called "Canadian!" One city can be named in which a depot for Canadian produce was opened, and where? in one of the poorest and lowest parts of the city! "American" beef, mutton, butter and cheese can be obtained at numerous places, while "Canadian" is unknown.

The present cattle trade was commenced in 1876, and had its inception in this city. It was really an experiment. No one knew any thing of it. Shippers, ship-owners and harbor authorities were all in ignorance of the requirements of the trade. The first steamer chartered could only carry 150 head of cattle, and now the same ship carries 350. At the ports of debarkation no preparations had been made. It was difficult for the Liverpool harbour authorities to believe cattle could be brought across the ocean in large numbers free from infection or disease, when in spite of every care and attention outbreaks of pleuro-pneumonia and other diseases could not be checked in Britain.

In the earlier days of the trade heavy losses were incurred. The

experience of to-day has indeed been dearly bought. Still it is highly satisfactory to learn that the losses are merely trifling.

	CATTLE.	LOST.		SHEEP.	LOST	
		No.	P. C.		No.	P. C.
The Dominion S.S. Line carried in 1882	6,057	41	0·67	20,241	522	2·57
Do., 1883	7,963	54	0·70	21,553	989	4·60

	CATTLE.	SHEEP.
Montreal exported in 1876	2,830	2,686
" " 1883	50,365	102,835

It was not until the third season that the Liverpool authorities became alive to the importance of this trade. When they did so, with commendable promptitude they erected those handsome and commodious lairages, pens, slaughter-houses, &c., which now expedite the trade and allow of a ship-load of animals being slaughtered within 24 hours of debarkation.

In addition to all the vexations, losses, &c., incurred in the earlier days from the want of sufficient knowledge of the requirements of the trade, as well as having the opposition of the British farmer and cattle dealers to overcome, the provisions of the Contagious Diseases (animals) Acts had to be complied with. The depredations caused in Britain during the past 20 years by numerous diseases are unfortunately only too well known; in spite of the most stringent measures, the Government has failed to entirely stamp out these diseases, and valuable herds and animals are still daily lost by their ravages.

Recent statistics shew that there are in the United Kingdom 32,237,958 sheep and lambs, the loss due to diseases brought on by the recent wet seasons is estimated at 2,889,000, or nine per cent. The Canadian farmer may complain about the severity of the winter, but he has nothing to fear compared to his British brother.*

To guard against any spread of these diseases strict quarantine laws have been established applicable to all foreign countries, which necessitated the cattle being slaughtered within 24 hours of debarkation, and at the port of arrival. It must be a subject of much congratulation and pride to us all, that the Dominion of Canada is the only country which has never come under the clauses of the Act, or been

* Dyke—loc. cit.

"scheduled." Fortunate it is for us we are free from restrictions, and long may we continue to be so. It is only those persons who have had experience of the workings of that measure who can understand what a bane it is to a country, or how it interferes in its trade. Exhibitors of live stock have frequently failed to come up to their usual standard, and orders to slaughter cattle at home markets have interfered with their prices. Under the Act, every time an animal is put into a cattle car, the car has to be disinfected before it is allowed to be used again; the floor has to be washed out, all offal removed, and the car has to receive a coating of lime white-wash; every pen used for loading, unloading, or holding cattle, be the time ever so short, has to be white-washed. To move animals by road, permission has to be obtained from the Local Authorities, who have plenty of inspectors always on the look out for a breach of the law.

The best illustration of the care devoted to cattle in our province, is afforded in the large byres in this city for fattening cattle for the English market. There are at present 4,000 cattle distributed over six large feeding stables, or byres, each of which contains about 600 head; and there are also a large number of pigs. Each byre is one open space, there are no partitions, the cattle stand close together from 40 to 50 in a row; between each row are 2 troughs separated by a footway for the attendant to pass along, the troughs are sufficiently far apart to prevent the animals from horning each other. At the rear a similar arrangement receives the manure, urine, etc., these troughs are about 3 ft. wide, 3 ins. deep at the top, and 9 ins. at the outfall. A simply arranged system of sluices lets the distillery wash flow into the troughs. Overhead is a large loft for hay, having openings directly over each line of troughs, through these the hay is dropped down directly to the animals. The "wash" is supplied directly from the distillery which is about 1,100 yards distant; it comes boiling hot, and is received in large vats holding 30,000 gallons each; it does not cool very much and is fed to the animals hot; each animal receives 20 gallons on the average, per diem. The stalls are carefully scraped out three times a day, all manure and urine is drawn into the troughs outside the buildings, from which it is run-off twice a day. The atmosphere of the byres is wonderfully sweet.

After the manure has been drawn into the outer troughs it is allowed to settle, and all solid matter is pitchforked on to a planked roadway, the liquid is further screened by being passed through

gratings one inch wide, after which it is carried down into the lake at Ashbridge's Bay. The byres and outfall troughs are all well flushed with fresh water every day. The solid manure is carted away, daily, by market gardeners and farmers in the neighbourhood of this city; they get it free, each contractor receives the manure of two rows, and there has never been any trouble nor has the manure been allowed to lie for more than twenty-four hours.

The animals come in during the month of October and go out in June, during that time they make from 1,500 to 1,800 lbs. in weight. In addition to the 20 gallons of "wash" each animal receives daily, it gets about a ton of hay during the season; this is fed to allow it to chew its cud and keep its bowels in order.

There is a great deal of difference of opinion among Sanitarians on the propriety of feeding animals on "distillery wash" or "dregs." Numerous investigations have been made into its qualities which have led to its being prohibited, as far as milch cows are concerned, in many cities and towns in the States and Britain. The question is still an open one, however.

ABATTOIRS.

No special care or arrangements appear to have been made in the early years of this century to regulate slaughter-houses, as we read that even in such large cities as Paris, London, and Edinburgh these buildings were in the densely populated parts of these cities; that no care was bestowed on them, and that the effluvium arising from them was overwhelming. Napoleon I. passed an edict regulating the abattoirs of Paris, in 1810, which fixed their sites, and on these sites they remain at present. The leading British cities did not bestir themselves in this matter till about thirty years ago.

The arrangements of the Paris abattoirs have been very generally followed, the buildings are placed in rectangular order and consist of the

Echaudoir, or particular division allotted for knocking down the animal.
Bouverie, the spaces, or sheds, where the animals are kept after a journey to rest and cool till the body gets to a normal condition.
Fondeurs, or boiling down houses, for meat unfit for human use, &c.
Triperies, the places used for cleaning the tripe of bullocks, and the fat, heads, and tripe of sheep and calves.

In addition there have been lately added a blood house, where all the blood is coagulated, or treated for the albumen, which is used in

calico printing. In Edinburgh, the blood which was at one time wasted is now sold and brings from £800 to £1,200 sterling per annum.

One of the first requisites for a place intended for the slaughtering of cattle is absolute cleanliness, it becomes an essential to have all appliances connected with abattoirs of the cleanest and most simple and easily-cleaned nature. Vermin must also be excluded from them. In Edinburgh the houses are built of dressed stone, the floors are laid on a layer of Portland cement concrete, twelve inches deep, the surface being paved with large close jointed flagstones; the roadways between the buildings are also laid on cement concrete, the stone blocks being laid in close sets well jointed. All abattoirs are at all times open to the inspection of city health officers, and are supplied with plenty of water for flushing purposes. One of the best substances for abattoir floors is cement concrete, which can be prepared to any degree of surface roughness, to prevent slipping; being homogeneous and of almost indestructible consistence, it will stand any amount of wear and tear, and it is very easily washed and kept clean.

Few of our Canadian cities are well placed regarding abattoir arrangements, there are too many abattoirs mixed up among dwelling-houses, and health-inspectors have not yet the compulsory powers they must have before they can abate these nuisances. The author has learned, with much surprise, that offal is still fed to hogs at many abattoirs, and that there is a decided demand and preference for pork so fed. This reprehensible and dangerous custom cannot be too strongly censured.

The systems adopted in England for slaughtering and handling the carcases, are shewn by the drawings on the wall, and are an enlargement of the arrangements now in use at several pork packing and other factories; this system saves all handling of the meat and preserves it better than in those cases where it has to be carried on men's shoulders to carts, and upon carts to the butcher stalls.*

It is to be hoped that in any new abattoirs to be built in any of our cities, care will be taken to arrange everything with a view to absolute cleanliness, and that a plentiful supply of water will be laid on. Proper buildings can easily be erected for the destruction of all waste

* The abattoir machinery referred to is known as Meiklejon's Patent Abattoir Machinery and Fittings. Further information on this matter can be obtained from the author.

matter, or the conversion of it into chemical manure for which a market can readily be found; by these means what is now a foul nuisance and decided evil can be remedied at a moderate cost, the health of the municipality guaranteed, and much valuable matter now being lost turned into a source of revenue.

In the discussion that followed, Dr. Oldright stated that 50,000 gallons of liquid manure mingled with solid particles are daily carried into Ashbridge's Bay to the detriment of the health of those residing in the vicinity. The slaughter-houses are abominable, and that on the Don is a worse nuisance than Mr. Gooderham's byres. He thought that anything that made life less enjoyable, should, if possible, be done away with, even though it might not be practicable to show that there was a direct connexion between this particular nuisance, and the prevalence of any given disease or class of diseases. He asked the assistance of the Institute to enable the Board of Health to carry certain changes in the law in the general interest of the public.

Mr. George Murray spoke as to the advisability of devising laws for the prevention of such nuisances.

Mr. George Acheson raised the question as to the wholesomeness of meat in which the blood has been allowed to remain.

Mr. Alan Macdougall thought that to feed pigs on animal offal increased their liability to become infested with *cestoidea*, chiefly the *trichina spiralis*.

HYPNOTISM AND ITS PHENOMENA.

BY P. H. BRYCE, M. A., M. B., L. R. C. P. & S. Edin.

(Read before the Institute on the 11th March, 1882.)

In choosing this subject upon which to base some remarks, I feel how imperfectly anything I may say can serve to convey to you any adequate idea of the strange series of phenomena attendant upon the hypnotic state. My excuse, however, for choosing it must be given in the fact that some months ago a patient came under my charge, after having passed through the hands of several physicians, who had given different opinions as to the real nature of her malady. Seeing her for the first time, I was at once struck by the similarity of her condition and appearance to certain patients I had been accustomed to see in Professor Charcot's wards in the Hospice de Salpêtrière in Paris.

Her lower limbs were found in a condition of tonic rigidity, while various clonic contractures were taking place in various other sets of muscles. With the ophthalmoscope I endeavored to make out the vascular state of the retina, but was through her movements unable to do so. To perfect, however, my diagnosis I tried the hypnotizing experiment, and in a short time she had passed into a profound slumber. After she had so passed into a slumber I raised an eyelid, thus allowing light to strike upon the eye, when I found that a state of complete cataleptic rigidity had seized upon that side of the body. My diagnosis was finally made beyond doubt when I found that the slightest pressure over the ovaries, after she was again awake, proved their state of extreme hyperæsthesia by inducing an hystero-epileptic attack which was checked by continued firm pressure upon them. Before me was, in very truth, a case of Hystero-epilepsy, precisely similar to those seen in Prof. Charcot's wards, and which have excited the wonder of all scientific men, who have ever had the good fortune, while in Paris, to visit the wards of Salpêtrière.

From the nature of the case it will be impossible for us to study the phenomena of hypnotism without to some extent introducing

other phenomena always present in hypnotic subjects (especially in hystero-epileptics); and since my experience of such is limited only to those persons, who have come under the charge of physicians, I shall leave to the apostles of animal-magnetism to explain the spiritual relations which they ostentatiously assume to exist between themselves and those to whom they communicate the *fluidic* force from their over-charged and hypermagnetic souls.

I have chosen Dr. Braid's word, Hypnotism, in preference to somnabulism as expressing more exactly the condition, and nothing more, which we wish to consider; and further prefer it to Charcot's word of "lethargy," applied to the state, since in our language this word has a meaning hardly applicable to what we wish to express.

Perhaps there is no subject about which have hung more awe-inspiring ideas and morbid curiosity than about this of hypnotism—or if we would rather somnabulism, mesmerism, *aut alter*; and there is no scientific subject at the present time which presents more physiological difficulties or pathological interest than the hypnotic phenomena, attendant upon certain—to use the mildest term—*functional* maladies. It would be foreign to the purpose of this paper for me to enter into any lengthy historical account of the many fanciful ideas, which have grown up around our subject; nor would it be very edifying to re-count the confused mass of credulity, charlatanry, and science, which has in the past, and in many quarters does still form part of the conception associated with the term hypnotism. Still it may be interesting to note that I have found in an edition of Galen that magnets, incantations, &c., are spoken of as therapeutic agents in mental affections; and I may further remark that Charcot has become so convinced that the New Testament demoniacs were persons afflicted with no other than epileptic and hystero-epileptic maladies, that, having witnessed so frequently amongst his own patients paroxysms similar to the recorded ones, he has actually had sketches made illustrative of these scriptural demoniacs. But within the present century we see an outgrowth from these pathological conditions, which have hypnotism as a phenomenon, in that pseudo-science termed variously animal-magnetism, biology, mesmerism, &c. It would seem as if there have been too many persons so filled with love for the extraordinary that when they encounter certain facts apparently inexplicable, instead of endeavouring calmly to search out causes prefer to rest in supernatural

explanations. With such then animal-magnetism has taken its origin. According to them some mysterious, imponderable, yet potent fluid passes from person to person: the manipulator of spirits has, doubtless at first honestly, and then afterward with conscious deception, thought his power over the passive subject of his will to be due to some peculiar magnetic virtue in his own constitution. In such persons has the hydra-headed monster of Spiritualism been conceived and reared; and only recently have scientific men been found brave enough to face credulity and ignorant prejudice, and deal with certain undoubted facts, endeavouring to explain them upon the true basis of physical and psychical science. We shall not trouble ourselves with the empiric consultations and diagnostications of Teste and Deleuze, finding thereby diseases that have never had an existence; nor how Vasseur-Lombard cured cancer by magnetism, nor yet of how diseased plants have been stimulated by its mysterious power to a more vigorous growth; but we shall endeavour, in at most a very imperfect way, to study some of the phenomena of this neurosis, produced, it may be, artificially or by pathological causes.

Defining then our subject, we would say that there are certain persons, mostly females, of such constitution, that they, by certain manipulations, simple or more or less complicated, may be brought into such a neurotic condition as that they may be made to pass into a deep sleep in which they may be kept at will for an almost indefinite number of hours. Such then is the apparently simple fact of hypnotism; but this apparently simple fact, I think we shall see as we proceed, will become one both of very great interest and of much difficulty as regards its explanation.

And first it becomes necessary for us to consider whether in this condition of hypnotism the physical system is in exactly the same condition as in natural sleep. As we all know the factors which enter into the causation of the unconscious state known as sleep are so varied that it is most natural that many explanations have been given of the state. Sömmer, as we know, supported by Pettenköfer and others, believed that sleep means exhaustion of the oxygen of the blood and tissues, which has taken place during the day, and that, when this is again stored up at night in sufficient quantity waking follows. While in all probability the fact of there being a greater consumption of oxygen during the day than at night is probably true, yet we are hardly prepared to accept the theory of

sleep founded on one isolated though comprehensive fact. Dr. Cappie's theory is one which seems to comprise many more of the factors entering into the causation of sleep. Briefly, he says: (1) there is with the growing exhaustion, towards evening, of all the tissues a lessened molecular activity of the cerebral cells, and (2) coincidently therewith a change in the capillary circulation of the brain so that less blood is supplied to the brain, and hence the volume of the brain is less. But (3) this situated within the immobile capsule of the cranium must have the hitherto occupied space, now again filled; hence, as Arthur Durham remarks, the result is that the blood in the venous sinuses is increased. But further, Mr. J. Hilton, F.R.C.S., remarks that the cerebro-spinal arachnoid fluid always equipoises the haemic condition of the brain, and especially of the parts surrounding the ventricles—thus resting the brain; and not only so, but also the relation between this fluid and the blood is always one of unstable equilibrium. But, once more, Dr. Hughlings Jackson has shown that the ophthalmoscopic disc is in sleep always in an anaemic condition. Now all this seems simple enough, yet I doubt not that many abnormal states may arise which will be found difficult to coapt with this theory. However, this theory would further seem to be supported by what we find present in many pathological conditions. Thus we know that in active delirium, dependent upon an hyperaemia and inflammation of the brain, sleeplessness is a common symptom, *e. g.*, acute mania and the early stages of acute meningitis, while again in the later stages of both there is unconsciousness and more or less complete coma arising from venous stasis and effusion of lymph into the cerebral tissues. This in an organ with such an enormous capillary circulation—the encephalon containing, according to Haller, $\frac{1}{5}$ of the total blood of the body—must produce the most disastrous effects upon its functional activity as has been experimentally shown in many ways. Thus pressure upon a portion of brain exposed by a fractured cranium has immediately produced a suspension of its functional activity, thereby inducing unconsciousness. That it is anaemia which has produced this state is evident from the fact that a removal of the pressure brings back immediately functional activity of the part.

Before we endeavour to draw a parallel between the physical conditions of natural sleep and induced hypnotism, we shall try and explain how the anaemia of natural sleep is produced.

First, then, we think it now conceded by all that there is a natural law by which all organic life unconsciously seeks rest, in order as it were to store up energy for the renewal of active functions. As far as we know all animals follow this law: we know as well that plants do. How this takes place in plants we know in the fact that the actinic rays of the sun, aiding the decomposition of carbonic acid by the plant and the assimilation by it of carbon, thereby become the exact idex of this functional activity. Nothing then seems more certain than that man's physical, and likewise intellectual, nature seeks in sleep that rest which enables the various organs to *revitalize* themselves by both lessening the physical waste, and the storing up of new energy. But this process, inherent in the natural constitution of man, must of course be carried on by means of natural processes. What are these? Following out embryogenic changes we must necessarily place nutrition of blood and its renovation first. But since nerve force is that which evolutionary progress has carried to its highest point of development in man, we feel that in adult man it should almost be placed first, so potent a regulator has it become of the processes of nutrition. We may say then that nerve force exists through all the degrees from extreme nerve tension to that of complete nerve relaxation, the various degrees depending upon the ability to assimilate nourishment, derived from the blood and external warmth, light, exercise, &c. Now in trying to explain physical phenomena and the part played by nerve matter in them, it is necessary to proceed with the greatest caution, since we frequently find popular expressions and scientific expressions diameterically opposed to one another. Thus the popular expression for nerve anaemia or nerve debility is nervousness, which in reality ought to mean the very opposite, viz., nerve force; and so a whole series of misused expressions originating in wrong pathological ideas might be given.

Starting then somewhere in the complex circle of cause and effect let us suppose that nerve force is given. Now it seems generally accepted that the ganglionic system of nerves, which especially subserves the functions of organic life, is that too which, by giving nerve supply to the muscular tissue of the blood vessels, regulates the blood supply of a part, either by contraction of the walls lessening the blood supply, or relaxation causing a temporary hyperaemia. (It should be noticed here that the hyperaemia attendant upon inflammation seems to some extent at least dependent upon some morbid

condition of the blood, affecting the vitality of the walls of the vessels; but more probably it is largely due to sensory reflex action of the nerves.) That this latter seems the commoner mode of action would seem to be shown from the fact that emotional influences of joy and pleasure with their opposites of sorrow and anger, produce their regular effects of heightened circulation in the capillaries in the one case, and pallor from spasmodic contraction of the same vessels in the other. We must here add to this the important factor of sympathetic nervous influence directly exerted upon the heart, probably from the vaso-motor centre in the medulla oblongata upon the accelerator ganglion in the one instance, and the depressor ganglion in the other, both of which have their supposed centres in its muscular tissues.

We now would seem to have sufficient data wherewith to proceed in our endeavour to explain the phenomena of hypnotism. We have explained the supposed physical conditions tending to produce sleep. Have we the same present in induced hypnotism? It seems to me that in a large degree we have. It is perfectly well known that the hypnotic state cannot be produced at will in all persons, and in others only with various degrees of ease. It is true, moreover, that persons in whom hypnotism can be produced are almost invariably those of an emotional tendency, or those in whom the equilibrium which in health exists between the cerebral and spinal systems is most readily destroyed—certainly those in whom the sympathetic nervous system is most readily acted upon. Nothing can express our views upon this point more exactly than the quotation of M. Jaccoud's remarks concerning hysteria. He says: "The physiological characteristics of Hysteria depend upon the importance of the opposing relations which exist between voluntary or cerebral innervation, and the involuntary or spinal. The performance of the regular functions of the nervous apparatus depends upon the natural and innate subordination of spinal activity to that of the cerebrum; this established hierarchy (which demonstrates among other things the experimental study of reflex motility) is the absolute condition of the normal harmony of the nervous functions. Now in hysteria this harmonic equilibrium is always broken and always in favour of the spinal cord; thus is produced a disorder which bears fatally upon the collective functions of innervation—a veritable cerebro-spinal ataxia which constitutes and characterizes the decay of cerebral action, and the predominance

of spinal action." He further remarks that the physiologist may produce the same condition in three ways: (1) by exaggerating the excitability of the spinal system by irritation of the centripetal nerves; (2) by exaggerating directly the action of the cord itself; and (3) by suppressing the functions of the brain.

These three conditions have each their pathological analogies, and they contain in themselves the totality of the pathogenic conditions of hysteria. Whatever has been the causation of this malady, he further says, we have always these two fundamental elements united, viz.: (1) the weakening of cerebral action, especially that of the will, and (2) the exaggeration of the automatic or spinal action (hyperkinesie spinale).

Thus we see that in these hysterical patients we have emotional subjects who are readily impressed by whatever may affect the sympathetic system, in other words, who are ruled too frequently by the emotions and too seldom by the will,—or as M. Jaccoud so well expresses it: "There is at least temporarily present a cerebral paresis." Now physiologically what does this mean? It must mean, if we adhere rigidly to the belief that the more or less complete abeyance of functional activity in a part is necessarily dependent upon a corresponding temporary absence of force-producing materials in the part, and, so far as we know, this means arterialized blood. For instance, pallor is an anaemia of the capillaries of the skin; while we have, unfortunately, too many examples showing that the functional activity of an arm or leg depends directly upon its nutrition. Moreover, our best authors give among the causes of hysteria, loss of blood, prolonged lactation, &c. The first of these shows that other than purely female disorders may be causes of this malady, *i. e.*, hysteria may occur in delicate and impressionable males as well as in females.

In claiming the anaemia theory as explaining these states I am perfectly well aware that there are some authorities, notably Brown-Sequard, who are opposed to it as being in many cases a sufficient explanation of either hysteria or epilepsy. I find in notes taken from his lectures on the peripheral irritation of nerves, that his explanation of these pathological conditions is not on the supposition of any slow or sudden unequal distribution of blood to the brain, but that he considers the attacks essentially due to reflex action from peripheral sensations creating impressions upon the brain centres. Then

follows a citation of cases where peripheral irritation induced epileptic attacks. No doubt these cases are facts, but I am inclined to the belief that most, if not all, of them can be explained on the anaemia theory. Let us select one example from many. He cites a case, where disease of the supra-renal capsules induced epileptic attacks. Now, here it would seem as if we had present much the same sort of peripheral irritation of the nerves, which we have in ovarian hyperaesthesia, &c.; and each is followed by an attack or paroxysm, due, we have reason to believe, to the irritation to the ganglionic nervous system inducing contraction of the brain, capillaries, &c. But, to proceed, assuming that since the hypnotic state is induced principally in persons of natural or induced emotional tendencies, and that in such there is present more or less of a cerebro-spinal ataxia, *i. e.*, a temporary suppression of will power or cerebral force, we necessarily have present a condition of cerebral anaemia, or the very same physiological condition which Cappie, Durham, Jackson, Schiff, &c., agree, is present in normal sleep.

Let us now refer to some of the conditions which exist in hypnotic individuals. You will remember the hypnotizing experiment used as a diagnostic aid in the case already referred to. The method, as remarked by Prof. Charcot, made use of for inducing the hypnotic state is for the most part immaterial, the subjective state of the patient being apparently the necessary condition. What, however, in most cases seems necessary is a fixity of gaze, or at least some impression made upon the visual organs, which we may consider in the light of an irritant. Thus the patient looking fixedly for a few seconds at a single point, placed a few inches in front, and a little above the level of the eyes, is seen to have the pupils first contract and then soon dilate, with this the eyelids are seen to droop, and the patient simultaneously shows signs of muscular relaxation; the head falls to one side or forward, stridulous breathing supervenes for a few moments, then the patient passes into a profound sleep. Other means, such as looking at a bright piece of silver, the Drummond light, or even closure of the eyelid with slight pressure on the eyeball, have all been used, producing the same results. We are now brought to the exceedingly difficult question of the physiological changes which have here taken place. To physiology, rather than pathology, must we look for our answer. First, then, we recognize the fact that the impression made by light or by pressure is made upon the retina,

thence the optic nerve. Thus, with the light we have the special irritant applied to this nerve of a special sense; and, as proved anatomically as well as by physiological experiments, this nerve reflects its impression along the *third* (3rd) nerve to the iris, through the ophthalmic ganglion, and, as we know, instantaneous iris contraction is the result. But the impression reflected upon this ganglion has for us the highest interest. In it are ganglion cells with fibres connecting with other sympathetic ganglia. Now, however great or little may be the optic sensibility here, we are certain of one thing in these cases, and that is of an extreme hyperaesthesia of the ganglionic nervous system. Since externally in the changes of the iris, we can see the proof of the above supposition, it seems logical for us to assume that the sensation reflected from the optic nerve creates upon the ganglionic system such an impression that it is communicated to the vaso-motor centre—seated in the medulla oblongata—of the cerebral arteries; and that thence is communicated an irritation which causes an instantaneous contraction of the cerebral arteries, (possibly also by the irritation supplied to the depressor ganglion of the heart,) thus creating an anaemia, an abeyance of cerebral functions, and as a consequence the hypnotic state. This hypothesis seems quite the same as the one by which Ferrier accounts for related cases, where from emotional states, as anger, &c., spasm of some of the cerebral arteries has taken place, producing temporary blindness, deafness or aphasia, or which were relieved by the use of the magnet overcoming the spasm. We must not forget to note as a factor in this hypnotizing process, that in all such subjects the will-power has been passing into abeyance, since we have already seen that in proportion, as this is absent the spinal, and certainly the sympathetic, hyper-excitability is increased.

Here again let me quote from M. Jaccoud on "Cerebro-Spinal Irritation," words appropriately describing the condition here present. He says:—"The abnormal excitation of the cerebro-spinal system, causes its first effects to be felt upon the vaso-motor system, whose impressibility is so readily shown by the instantaneous production of pallor and of blushing, whence an anaemia or rather secondary ischaemia, both of brain and cord, which increases the disorder of excitability and transforms it into a persistent condition of irritable feebleness. Both clinical facts as shown by Ferrier and the experiments of Van der Becke, Callenfels, Nathnagel, and Krishaber have

placed these hypotheses in the region of verified facts." How inconceivably impressible is the nerve system to influences, seems to be further substantiated from recent experiments by Jaeger, so wholly new, and, if true, so remarkable that I cannot refrain from a brief reference. To use his own words concerning his experiments with the chronoscope, he says, with reference to neural analysis :—" My discovery relates chiefly to the *gemeingefühl* (collective-feeling, emotions), which by physiologists is distinctly separated from the perception by the senses (the philological difference between soul and mind corresponds exactly to this physiological difference). The essential peculiarity of the *emotions* is that the accompanying functional changes are not limited only to a few anatomical parts of the body, but concern all parts of its muscles, nerves, glands, &c. In other words emotion is a condition of the whole body. Hence it follows that not only the sensory nerves undergo a change, but also the muscular or (*i. e.*, motor) nerves. That which is changed is the nervous excitability, and that which produces these changes are soluble substances which enter into the liquids of the body, and amongst which the volatile ones (odorous) produce the greatest effects. The changes of excitability are indicated by the motor nerves as a quantitative index of the conductibility of these nerves for perceptions. Thus we are enabled graphically to illustrate the peculiarity of the emotions by registering an involuntary movement, viz., that of the heart, since every such substance entering the system affects the rhythm of heart and pulse, and may be measured by the sphygmograph. Thus what the nerve of smell, smells, nerve of taste, tastes, and nerve of sight, sees, are all registered by the muscle nerve. He then gives diagrams of sphygmographic tracings of curves of joy (Jargonelle pears). of anger (rancid butter), of nausea (bad drinking water, &c.). Now, allowing that there is a basis of fact underlying what to many may seem fanciful theorizing, we further see how impressible is the nervous system, as shown time and again by Charcot's method for ending the hypnotic state by simply a puff of breath upon the face of the patient.

From these extended remarks, then, it would seem as if we have something like a definite explanation possible of the causation of the hypnotic state, which we may describe as at least a functional pathological state, having its near analogue physiologically in sleep, but with several additional phenomena superadded; and of all these the

most prominent is a remarkable condition of general hyperaesthesia of the spinal system of nerves. But we must beware of making this a too distinctive phenomenon of hypnotism, since we know that not only are different individuals very differently susceptible to external influences while asleep, but also that the same person at different times sleeps with varying degrees of sensibility to external impressions.

We have now to notice the condition into which the system is thrown during the somnabulistic state. Necessarily it is one in which cerebral force is wholly in abeyance. A most interesting illustration of this is seen in some of M. Charcot's experiments. For instance, a patient whom we may call Marie, is hypnotized; her eyes are opened by the operator, and she is told to look carefully at the bystander, that he is Ernestine, a friend of hers. Her eyes are again closed and her friend Ernestine is brought forward, and in the same manner Marie is told that Ernestine is the bystander. The operator now puffs upon her face and Marie awakes and treats the bystander as Ernestine, and Ernestine as the bystander. This delusion persists a long time unless she is again hypnotized, and the hallucination resolved. As we know, destruction of the cerebrum in frogs not only does not destroy, but seems to augment reflex spinal movements; and since, as we have seen, a hyperaesthesia is more or less constantly present in, at least, *plaques* or parts of the bodies of hypnotic patients, we naturally expect them while asleep to be peculiarly susceptible of external influences. Others again exhibit, what may be deemed truly wonderful, sensibility even while awake to external impressions. A Dr. Cowan, relates in the London *Lancet*, that a patient of his was so sensitive to external impressions, that the flying of a bird past a window with drawn curtains, and with the bed-curtains also drawn, produced in her a sudden jerking of the spinal muscles, extending, if violent, to the hands and legs, and all this without any conscious mental emotion. The same person heard, and was affected by sounds not appreciable to other persons, these sounds producing similar reflex movements to those of sight. Besides such examples we have many other examples of reflex spinal acts, as nausea and vomiting from bad sights or odours, quite apart it may be from any mental emotion. What, however, is most to be remarked in all these cases of undue reflex spinal acts, in these functional maladies at anyrate, is that their force is exactly in

proportion as cerebral influence is in abeyance; and further we notice that the longer this state exists so much the more difficult is it to regain cerebral control over reflex spinal movements. Many instances of this latter fact have been witnessed in the hystero-epileptic patient already alluded to. Thus while examining the eye with the ophthalmoscope I have asked her to look down, up, &c. At times this has been done with ease, while at others no apparent efforts on her part could overcome the ataxia due to the lack of cerebral force over reflex spinal action. Again the hyper-excitability of afferent sensory nerves induced by this condition is in its effects readily appreciated. Let us suppose a patient hypnotized and sleeping quietly, the whole muscular system being apparently relaxed. Here we find that the sensibility is so great that very slight friction along the course of any nerve causes tonic contractures of the corresponding muscles supplied by its branches to take place. This I have frequently witnessed in sets of muscles in all parts of the body. What the pathological condition is, inducing this state is in some instances difficult to explain; but a curious experiment which I had the good fortune to witness in M. Charcot's laboratory would seem to throw some light upon the subject. There was present a patient, very healthy-looking, well developed, of fair complexion, and of sanguine temperament, but one of peculiarly emotional tendencies. The experiment upon her was as follows: She, having been first hypnotized, was sleeping peacefully while sitting in her chair. An assistant now bandaged the right arm, and having tied it above the bandage showed it to be anaemic. Now by slight pressure upon the ulnar nerve at the elbow the form of contracture *en griffe* was set up in the corresponding fingers of that side. A large magnet was then placed in contact with the left arm when, wonderful to relate, there followed a slight muscular tremor in the muscles of the left arm, and thereafter the same contractures took place in the muscles of that hand, the contractures on the right side being correspondingly relaxed at the same time, but by irritation were again induced, there being contractures thus present in both at once. I did not hear M. Charcot's theory as to the causation of this phenomenon, but it seems to me that we have a right to assume that:—(1) anaemia of the right arm made it very irritable and sensible of impressions; (2) when the cerebrum was even slightly impressed it set up motor reflex action and contractions took place; (3) and in the third, and

strangest of all, that of the magnet's influence, we must assume that it, like the static electricity of the plate electric machine produces with its high tension a state of extreme hyperaesthesia, or impressibility, so that the impression made upon the sensory centres from the right arm irritation, is now great enough to excite through the commissural fibres the same reflex action on the left side. But further, it was found that on removing the tourniquet from the right arm the contractures of the left gradually relaxed, and the contractures came back again in the right arm, but slowly and not very completely.

We must confess that we have present what seem to be at first two contradictory phenomena: (*a*) anaemia producing hyper-excitability in one arm, (*b*) while in the other tonic magnetic influence has produced, at least as far as effects go, a similar state of great sensibility.

But though we may fail in fully explaining this peculiar condition, yet I think we can gain at least one step in advance by noticing an explanation given by Dr. Broadbent concerning some of the causes of paralysis from hemorrhage into the *corpora striata* and *thalami optici*. He thinks it can be shown that where the muscles of corresponding parts of the body constantly act in concert the nerve nuclei of these muscles are so connected by commissural fibres as to be *pro tanto* a single nucleus. Now supposing that the magnetic influence has greatly increased the impressibility of the left side we may fairly infer that the reflex action setting forth from the sensorial nucleus which was impressed by the irritation on the right side, and which caused the tonic contraction of muscles in the right arm (being of a certain quantity which we may call x), has been transferred to that muscle having the greater temporary conductibility. Thus we have now relaxation in the muscles of the right arm, and the phenomenon of tonic contraction in those of the left. Let us now remove the temporary stimulus of the magnet and we have the original impression made upon the nucleus, again transferred to the right arm but in a greatly diminished degree, since this side has again become that of greatest excitability.

Before closing there is another condition induced in patients whilst in the hypnotic state so strange—we might say marvellous—and unusual that it demands some few remarks. I refer to the remark already made that, when the one eye of a hypnotized patient is

opened, the impression produced, we must assume, by light induces some new condition by which that side of the body of the patient is thrown into a cataleptic state. Now before inquiring what this change is, it may be well for us to try and explain the pathological condition present in a catalepsy which may attack persons without their first passing into the hypnotized state. At the outset we must confess to the unsatisfactory information which most of our authors give us on the subject. All that even Bristow says is, "that in cataleptics we have a class of cases difficult to classify. and difficult to attach to specific lesions or specific conditions of the nervous system." We do find, however, in M. Jaccoud already quoted from something which really does aid us.

He says :—"Catalepsy is a spasmodic paroxysm and is constituted of two elements: (1) the suspension of cerebral operations, or their external manifestations; (2) the increase of the spontaneous and reflex tonicity (innervation de stabilitó) in the muscles of animal life. The abolition of cerebral action presents itself under two forms (rather degrees) which imply different organic localizations: in one (*a*) there is total loss of consciousness, viz., of sensation, perception, ideaism and its consecutive acts, and this can be interpreted only by the inertia of the grey substance of the hemispheres; in the other (*b*) consciousness is not suspended, perception and ideasim are complete, but lack the last link of the chain, *i. e.*, the motor intuition cannot be communicated to the motor apparatus. Here it is clear the cortical substance is normal, but the inertia is in the conductive fibres which bind together the organizing apparatus and the performing apparatus. Nevertheless the result is the same; tonic spasm is present, keeping various sets of muscles in whatever position placed. And this tonic spasm (spasmes du tonics) is a lasting tension. Here we have a most noticeable fact in the marked increase in the innervation of of stability. The tension keeping up this stable condition of the muscles must be looked upon as a reflex phenomenon, provoked by the molecular change (elongation or shortening) which the communicative movements cause the muscles to undergo. It is this molecular change which is the centripetal excitation necessary to all reflex movements; and this stimulus repeats itself every time that the muscle is moved. One difficulty exists in the constant relation which binds the quantity of tension to that of passive movement in such a way that the reflex spasm produced by this latter is always

rigidly adequate to it, and arrests the muscles exactly in the position which one gives to them. Benedikt notes, concerning this point, that according to the researches of Volkmann the contractile capacity of muscle augments or diminishes according as it is shortened or elongated by traction." Evidently, we think, M. Jaccoud has thrown much light on the pathology of the symptoms of catalepsy; but as he says, the causation of the malady is yet obscure;—or, how are produced those opposed states of the cerebral and spinal centres, and why are the symptoms limited to the muscles of animal life?

Referring again to the cataleptic condition associated with the hypnotic state, we ask what changes take place in the system, which by the simple raising of an eyelid effect the change into what M. Jaccoud says is one of increased spontaneous and reflex tonicity?

First, then, in hypnotism the first of Jaccoud's cataleptic postulates is present, viz., the suspension of cerebral operations and their external manifestations. How has it been possible for light to produce all these changes? We have already noted the hyper-excitability of the muscular nerves present in hypnotism, causing muscular contractions when subject to the slightest irritation. We have further supposed that light has been the excitant or irritant inducing sleep with cerebral force in abeyance. Again we must remember the muscular relaxation taking place when hypnotism is induced. Evidently then our assumed nerve spasm has here passed off. But on opening the eye of the patient the excitant is again present with cerebral operations wholly in abeyance; hence we may suppose that the irritant affecting the optic nerve not only renews the spasm previously present and setting out from the sympathetic nerve cells residing in the medulla oblongata, thereby not only making the cerebro-spinal ataxia more complete, but also as a consequence leaving the spinal cord perfectly separated from cerebral influence; and, moreover, having an irritant in the form of light constantly producing a central influence upon it, we have it held in a state accurately defined by M. Jaccoud as *innervation de stabilité*.

But, gentlemen, our already too long paper must be brought to a close. These hypotheses and suggestions are only made by us as possible explanations of a series of phenomena both strange and unusual. It will indeed afford us a real pleasure when advancing medical science will have rescued many of these questions from the mists still enveloping them, and when the pure light of day will be

seen illuminating them as it now does the many common maladies which we daily encounter. Most truly would we express the fervent prayer of Tennyson :

> "Let knowledge grow from more to more,"

for to no other as much as to the true physician does this desire come that thereby the sum of human ills may be lessened, and the saddened face of a suffering humanity be illumined, let us hope, with spontaneous gratitude towards a profession which, with all its imperfections, is yet most earnest in the promotion of man's highest mental as well as physical well-being.

Many are the points concerning these neurotic puzzles which we have left untouched ; but it is hoped that other more experienced minds, and pens, wielded by other more facile hands, will take these up, adding thereby to the sum total of that medical knowledge, one of the many glories of the future for, as our Laureate sings,

> "And the thoughts of men are widened with the process of the sun."

n Institute, March 3rd, 1883].

CIPLES

F THE

OF THE HIGHER DEGREES,

PLICATIONS.

PAXTON YOUNG,
, Canada.

CONTENTS.

$$r_1 = \frac{1}{m}\left(g + \Delta_1^{\frac{1}{m}} + a_1\Delta_1^{\frac{2}{m}} + b_1\Delta_1^{\frac{3}{m}} + \ldots + e_1\Delta_1^{\frac{m-2}{m}} + h_1\Delta_1^{\frac{m-1}{m}}\right);$$

where g is rational, and a_1, b_1, etc., involve only surds subordinate to $\Delta_1^{\frac{1}{m}}$. §38, 47.

7. The equation $F(x) = 0$ has an auxiliary equation of the $(m - 1)^{\text{th}}$ degree. §35, 52.

8. If the roots of the auxiliary be $\Delta_1, \delta_2, \delta_3, \ldots, \delta_{m-1}$, the $m - 1$ expressions in each of the groups

$$\Delta_1^{\frac{1}{m}}\delta_{m-1}^{\frac{1}{m}},\quad \delta_2^{\frac{1}{m}}\delta_{m-2}^{\frac{1}{m}},\ldots,\quad \delta_{m-1}^{\frac{1}{m}}\Delta_1^{\frac{1}{m}},$$

$$\Delta_1^{\frac{2}{m}}\delta_{m-2}^{\frac{1}{m}},\quad \delta_2^{\frac{2}{m}}\delta_{m-4}^{\frac{1}{m}},\ldots,\quad \delta_{m-1}^{\frac{2}{m}}\delta_2^{\frac{1}{m}},$$

$$\Delta_1^{\frac{3}{m}}\delta_{m-3}^{\frac{1}{m}},\quad \delta_2^{\frac{3}{m}}\delta_{m-6}^{\frac{1}{m}},\ldots,\quad \delta_{m-1}^{\frac{3}{m}}\delta_3^{\frac{1}{m}},$$

and so on, are the roots of a rational equation of the $(m-1)^{\text{th}}$ degree. The $\frac{m-1}{2}$ terms

$$\Delta_1^{\frac{1}{m}}\delta_{m-1}^{\frac{1}{m}},\quad \delta_2^{\frac{1}{m}}\delta_{m-2}^{\frac{1}{m}},\ldots,\quad \delta_{\frac{m-1}{2}}^{\frac{1}{m}}\delta_{\frac{m+1}{2}}^{\frac{1}{m}},$$

are the roots of a rational equation of the $\left(\frac{m-1}{2}\right)^{\text{th}}$ degree. §39, 44, 55.

9. Wider generalization. §45, 57.

10. When the equation $F(x) = 0$ is of the first class, the auxiliary equation of the $(m - 1)^{\text{th}}$ degree is irreducible. §35. Also the roots of the auxiliary are rational functions of the primitive m^{th} root of unity. §36. And, in the particular case when the equation $F(x) = 0$ is the reducing Gaussian equation of the m^{th} degree to the equation $x^n - 1 = 0$, each of the $\frac{m-1}{2}$ expressions,

$$\Delta_1^{\frac{1}{m}}\delta_{m-1}^{\frac{1}{m}},\quad \delta_2^{\frac{1}{m}}\delta_{m-2}^{\frac{1}{m}},\ \&c.,$$

has the rational value n. §41. Numerical verification. §42.

11. Solution of the Gaussian. §43.

12. Analysis of solvable irreducible equations of the fifth degree. The auxiliary biquadratic either is irreducible, or has an irreducible sub-auxiliary of the second degree, or has all its roots rational. The three cases considered separately. Deduction of Abel's expression for the roots of a solvable quintic. §58-74.

PRINCIPLES.

§1. It will be understood that the surds appearing in the present paper have *prime numbers* for the denominators of their indices, unless where the contrary is expressly stated. Thus, $2^{\frac{1}{15}}$ may be regarded as $h^{\frac{1}{5}}$, a surd with the index $\frac{1}{5}$, h being $2^{\frac{1}{3}}$. It will be understood also that no surd appears in the denominator of a fraction. For instance, instead of $\frac{2}{1 + \sqrt{-3}}$ we should write $\frac{1 - \sqrt{-3}}{2}$. When a surd is spoken of as occurring in an algebraical expression, it may be present in more than one of its powers, and need not be present in the first.

§2. In such an expression as $\sqrt{2} + (1 + \sqrt{2})^{\frac{1}{3}}$, $\sqrt{2}$ is *subordinate* to the *principal* surd $(1 + \sqrt{2})^{\frac{1}{3}}$, the latter being the only principal surd in the expression.

§3. A surd that has no other surd subordinate to it may be said to be *of the first rank;* and the surd $h^{\frac{1}{c}}$, where h involves a surd of the $(a - 1)^{\text{th}}$ rank, but none of a higher rank, may be said to be *of the a^{th} rank.* In estimating the rank of a surd, the denominators of the indices of the surds concerned are always supposed to be prime numbers. Thus, $3^{\frac{1}{4}}$ is a surd of the second rank.

§4. An algebraical expression in which $\Delta_1^{\frac{1}{m}}$ is a principal (see §2) surd may be arranged according to the powers of $\Delta_1^{\frac{1}{m}}$ lower than the m^{th}, thus,

$$\frac{1}{m}\left(g_1 + k_1 \Delta_1^{\frac{1}{m}} + a_1 \Delta_1^{\frac{2}{m}} + b_1 \Delta_1^{\frac{3}{m}} + \ldots + e_1 \Delta_1^{\frac{m-2}{m}} + h_1 \Delta_1^{\frac{m-1}{m}}\right) \quad (1)$$

where g_1, k_1, a_1, etc., are clear of $\Delta_1^{\frac{1}{m}}$.

§5. If an algebrical expression r_1, arranged as in (1), be zero, while the coefficients g_1, k_1, etc., are not all zero, an equation

$$\omega \Delta_1^{\frac{1}{m}} = l_1 \tag{2}$$

must subsist; where ω is an m^{th} root of unity; and l_1 is an expression involving only such surds exclusive of $\Delta_1^{\frac{1}{m}}$ as occur in r_1. For, let the first of the coefficients h_1, e_1, etc., proceeding in the order of the descending powers of $\Delta_1^{\frac{1}{m}}$, that is not zero, be n_1, the coefficient of $\Delta_1^{\frac{s}{m}}$. Then we may put

$$mr_1 = n_1\{f(\Delta_1^{\frac{1}{m}})\} = n_1 \Delta_1^{\frac{s}{m}} + \text{etc.} = 0.$$

Because $\Delta_1^{\frac{1}{m}}$ is a root of each of the equations $f(x) = 0$ and $x^m - \Delta_1 = 0$, $f(x)$ and $x^m - \Delta_1$ have a common measure. Let their H. C. M., involving only such surds as occur in $f(x)$ and $x^m - \Delta_1$, be $\varphi(x)$. Then, because $\psi(x)$ is a measure of $x^m - \Delta_1$, the roots of the equation

$$\varphi(x) = x^c + p_1 x^{c-1} + p_2 x^{c-2} + \text{etc.} = 0$$

are $\Delta_1^{\frac{1}{m}}$, $\omega_1 \Delta_1^{\frac{1}{m}}$, $\omega_2 \Delta_1^{\frac{1}{m}}$, ..., $\omega_{c-1} \Delta_1^{\frac{1}{m}}$; where ω_1, ω_2, etc., are distinct primitive m^{th} roots of unity. Therefore,

$$\Delta_1^{\frac{c}{m}} (\omega_1 \omega_2 ..) (-1)^c = p_c$$

Now c is a whole number less than m but not zero; and, by §1, m is prime. Therefore there are whole numbers n and h such that

$$\Delta_1^{\frac{cn}{m}} (\omega_1 \omega_2 ..)^n (-1)^{cn} = \Delta_1^{\frac{1}{m}} \Delta_1^h (\omega_1 \omega_2 ..)^n (-1)^{cn} = p_c^n.$$

Therefore, if $(\omega_1 \omega_2 ..)^n = \omega$, and $l_1 \Delta_1^h (-1)^{cn} = p_c^n$, $\omega \Delta_1^{\frac{1}{m}} = l_1$.

§6. Let r_1 be an algebraical expression in which no root of unity having a rational value occurs in the surd form $1^{\frac{1}{m}}$. Also let there be in r_1 no surd $\Delta_1^{\frac{1}{m}}$ not a root of unity, such that

$$\Delta_1^{\frac{1}{m}} = e_1 \,, \tag{3}$$

where e_1 is an expression involving no surds of so high a rank as $\Delta_1^{\frac{1}{m}}$ except such as either are roots of unity, or occur in r_1 being at the same time distinct from $\Delta_1^{\frac{1}{m}}$. The expression r_1 may then be said to have been *simplified* or to be *in a simple state.*

§7. Some illustrations of the definition in §6 may be given. The root $8^{\frac{1}{3}}$ cannot occur in a simplified expression r_1; for its value is 2ω, ω being a third root of unity; but the equation $8^{\frac{1}{3}} = 2\omega$ is of the inadmissible type (3). Again, the root $\sqrt{5}$ cannot occur in a simplified expression; for, ω_1 being a primitive fifth root of unity, $\sqrt{5} = 2\,(\omega_1 + \omega_1^4) + 1$; an equation of the type (3). Once more, a root of the cubic equation $x^3 - 3x - 4 = 0$, in the form $(2 + \sqrt{3})^{\frac{1}{3}} + (2 - \sqrt{3})^{\frac{1}{3}}$, is not in a simple state, because $(2 - \sqrt{3})^{\frac{1}{3}} = (2 - \sqrt{3})\,(2 + \sqrt{3})^{\frac{2}{3}}$.

§8. Let
$$p_1\Delta_1^{\frac{m-1}{m}} + p_2\Delta_1^{\frac{m-1}{m}} + \,..\, + p_m = 0\,; \tag{4}$$
where $\Delta_1^{\frac{1}{m}}$ is a surd occurring in a simplified expression r_1; and p_1, p_2, etc., involve no surds of so high a rank as $\Delta_1^{\frac{1}{m}}$, except such as either are roots of unity, or occur in r_1 being at the same time distinct from $\Delta_1^{\frac{1}{m}}$. The coefficients p_1, p_2, etc., must be zero separately. For, by §5, if they were not, we should have $\omega\Delta_1^{\frac{1}{m}} = l_1$, ω being an m^{th} root of unity, and l_1 involving only surds in (4) distinct from $\Delta_1^{\frac{1}{m}}$; an equation of the inadmissible type (3).

§9. The expression r_1 being in a simple state, we may use R as a generic symbol to include the various particular expressions, say r_1, r_2, r_3, etc., obtained by assigning all their possible values to the surds involved in r_1, with the restriction that, where the base of a surd is unity, the rational value of the surd is not to be taken into account. These particular expressions, not necessarily all unequal, may be called *the particular cognate forms of R.* For instance, if $r_1 = 1^{\frac{1}{2}}$, R has two particular cognate forms, the rational value of the

third root of unity not being counted. If $r_1 = (1 + \sqrt{2})^{\frac{1}{3}}$, R has six particular cognate forms all unequal. Should $r_1 = (2 + \sqrt{3})^{\frac{1}{3}} + (2 - \sqrt{3})(2 + \sqrt{3})^{\frac{2}{3}}$, R has six particular cognate forms, but only three unequal, each of the unequal forms occurring twice.

§10. Proposition I. An algebraical expression r_1 can always be brought to a simple state.

For r_1 may be cleared of all surds such as $1^{\frac{1}{m}}$ having a rational value. Suppose that r_1 then involves a surd $\Delta_1^{\frac{1}{m}}$, not a root of unity, by means of which an equation such as (3) can be formed. Substitute for $\Delta_1^{\frac{1}{m}}$ in r_1 its value e_1 as thus given. The result will be to eliminate $\Delta_1^{\frac{1}{m}}$ from r_1 without introducing into the expression any *new* surd as high in rank as $\Delta_1^{\frac{1}{m}}$, and at the same time not a root of unity. By continuing to make all the eliminations of this kind that are possible, we at last reach a point where no equation of the type (3) can any longer be formed. Then because, by the course that has been pursued, no roots of the form $1^{\frac{1}{m}}$ having a rational value have been left in r_1, r_1 is in a simple state.

§11. It is known that, if N be any whole number, the equation whose roots are the primitive N^{th} roots of unity is rational and irreducible.

§12. Let N be the continued product of the distinct prime numbers n, a, b, etc. Let ω_1 be a primitive n^{th} root of unity, θ_1 a primitive a^{th} root of unity, and so on. Let ω represent any one indifferently of the primitive n^{th} roots of unity, θ any one indifferently of the primitive a^{th} roots of unity, and so on. Let $f(\omega_1, \theta_1, \text{etc.})$ be a rational function of ω_1, θ_1, etc. Then a corollary from §11 is, that if $f(\omega_1, \theta_1, \text{etc.}) = 0$, $f(\omega, \theta, \text{etc.}) = 0$. For t_1 being a primitive N^{th} root of unity, and t representing any one indifferently of the primitive N^{th} roots of unity, we may put

$$f(\omega_1, \theta_1, \text{etc.}) = a_1 t_1^{N-1} + a_2 t_1^{N-2} + \text{etc.} = 0,$$

$$\text{and } f(\omega, \theta, \text{etc.}) = a_1 t^{N-1} + a_2 t^{N-2} + \text{etc.};$$

where the coefficients a_1, a_2, etc., are rational. Should these coefficients be all zero, $f(\omega, \theta, \text{etc.}) = 0$. Should they not be all zero, let a_r be the first that is not zero. Then we may put

$$f(\omega_1, \theta_1, \text{etc.}) = a_r \left\{ \varphi(t_1) \right\} = a_r t_1^{N-r} + \text{etc.} = 0.$$

Therefore, t_1 is a root of the rational equation $\varphi(x) = 0$, being at the same time a root of the rational (see §11) equation $\psi(x) = 0$, whose roots are the primitive N^{th} roots of unity. Hence $\psi(x)$ and $\varphi(x)$ have a common measure. But by §11, $\psi(x)$ is irreducible. Therefore it is a measure of $\varphi(x)$; and the roots of the equation $\psi(x) = 0$ are roots of the equation $\varphi(x) = 0$. Therefore,

$$f(\omega, \theta, \text{etc.}) = a_r \left\{\varphi(t)\right\} = 0.$$

§13. Another corollary is, that if

$$f(\omega_1, \theta_1, \text{etc.}) = h_1\omega_1^{n-1} + h_2\omega_1^{n-2} + \ldots + h_n = 0,$$

where h_1, h_2, etc., are clear of ω_1, the coefficients h_1, h_2, etc., are all equal to one another. For, by §12, because $f(\omega_1, \theta_1, \text{etc.}) = 0$, $f(\omega, \theta_1, \text{etc.}) = 0$. Therefore $\omega \left\{f(\omega, \theta_1, \text{etc.})\right\} = 0$. In $\omega \left\{f(\omega, \theta_1, \text{etc.})\right\}$ give ω successively its $n-1$ different values. Then, in addition,

$nh_1 = h_1 + h_2 + \ldots + h_n$. Similarly, $nh_2 = h_1 + h_2 + \ldots + h_n \; \therefore \; h_1 = h_2$.
In like manner all the terms h_1, h_2, etc., are equal to one another.

§14. Proposition II. If the simplified expression r_1, one of the particular cognate forms of R, be a root of the rational equation $F(x) = 0$, all the particular cognate forms of R are roots of that equation.

For, let r_2 be a particular cognate form of R. By §12, the law to be established holds when there are no surds in r_1 that are not roots of unity. It will be kept in view that, according to §1, when roots of unity are spoken of, such roots are meant as $1^{\frac{1}{m}}$, m being a prime number. Assume the law to have been found good for all expressions that do not involve more than $n-1$ distinct surds that are not roots of unity; then, making the hypothesis that r_1 involves not more than n distinct surds that are not roots of unity, the law can be shown still to hold; in which case it must hold universally. For, let $\Delta_1^{\frac{1}{m}}$, not a root of unity, be a surd of the highest rank (see §3) in r_1. Then $F(r_1)$ may be taken to be the expression (1), and $F(r_2)$ to be the expression formed from (1) by selecting particular values of the surds involved under the restriction specified in §9. In passing from r_1 to r_2, let $\Delta_1^{\frac{1}{m}}$, a_1, etc., become respectively $\Delta_2^{\frac{1}{m}}$, a_2, etc. Then

$$m\left\{F(r_1)\right\} = h_1 \, \Delta_1^{\frac{m-1}{m}} + e_1 \, \Delta_1^{\frac{m-2}{m}} + \text{etc.} = 0,$$

$$\text{and } m\left\{F(r_1)\right\} = h_2 \, \Delta_2^{\frac{m-1}{m}} + e_2 \, \Delta_2^{\frac{m-2}{m}} + \text{etc.}$$

Therefore, t_1 is a root of the rational equation $\varphi(x) = 0$, being at the same time a root of the rational (see §11) equation $\psi(x) = 0$, whose roots are the primitive N^{th} roots of unity. Hence $\psi(x)$ and $\varphi(x)$ have a common measure. But by §11, $\psi(x)$ is irreducible. Therefore it is a measure of $\varphi(x)$; and the roots of the equation $\psi(x) = 0$ are roots of the equation $\varphi(x) = 0$. Therefore,

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[*Read before the Canadian Institute, March 3rd, 1883*].

PRINCIPLES

OF THE

SOLUTION OF EQUATIONS OF THE HIGHER DEGREES,

WITH APPLICATIONS.

BY GEORGE PAXTON YOUNG,

Toronto, Canada.

CONTENTS.

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$$f(\omega_1, \theta_1, \text{etc.}) = a_r \{ \varphi(t_1) \} = a_r t_1^{N-r} + \text{etc.} = 0.$$

Therefore, t_1 is a root of the rational equation $\varphi(x) = 0$, being at the same time a root of the rational (see §11) equation $\psi(x) = 0$, whose roots are the primitive N^{th} roots of unity. Hence $\psi(x)$ and $\varphi(x)$ have a common measure. But by §11, $\psi(x)$ is irreducible. Therefore it is a measure of $\varphi(x)$; and the roots of the equation $\psi(x) = 0$ are roots of the equation $\varphi(x) = 0$. Therefore,

$$f(\omega, \theta, \text{etc.}) = a_r \left\{\varphi(t)\right\} = 0.$$

§13. Another corollary is, that if

$$f(\omega_1, \theta_1, \text{etc.}) = h_1\omega_1^{n-1} + h_2\omega_1^{n-2} + \ldots + h_n = 0,$$

where h_1, h_2, etc., are clear of ω_1, the coefficients h_1, h_2, etc., are all equal to one another. For, by §12, because $f(\omega_1, \theta_1, \text{etc.}) = 0$, $f(\omega, \theta_1, \text{etc.}) = 0$. Therefore $\omega \left\{f(\omega, \theta_1, \text{etc.})\right\} = 0$. In $\omega \left\{f(\omega, \theta_1, \text{etc.})\right\}$ give ω successively its $n-1$ different values. Then, in addition,

$nh_1 = h_1 + h_2 + \ldots + h_n$. Similarly, $nh_2 = h_1 + h_2 + \ldots + h_n \therefore h_1 = h_2$. In like manner all the terms h_1, h_2, etc., are equal to one another.

§14. Proposition II. If the simplified expression r_1, one of the particular cognate forms of R, be a root of the rational equation $F(x) = 0$, all the particular cognate forms of R are roots of that equation.

For, let r_2 be a particular cognate form of R. By §12, the law to be established holds when there are no surds in r_1 that are not roots of unity. It will be kept in view that, according to §1, when roots of unity are spoken of, such roots are meant as $1^{\frac{1}{m}}$, m being a prime number. Assume the law to have been found good for all expressions that do not involve more than $n-1$ distinct surds that are not roots of unity; then, making the hypothesis that r_1 involves not more than n distinct surds that are not roots of unity, the law can be shown still to hold; in which case it must hold universally. For, let $\Delta_1^{\frac{1}{m}}$, not a root of unity, be a surd of the highest rank (see §3) in r_1. Then $F(r_1)$ may be taken to be the expression (1), and $F(r_2)$ to be the expression formed from (1) by selecting particular values of the surds involved under the restriction specified in §9. In passing from r_1 to r_2, let $\Delta_1^{\frac{1}{m}}$, a_1, etc., become respectively $\Delta_2^{\frac{1}{m}}$, a_2, etc. Then

$$m\left\{F(r_1)\right\} = h_1 \Delta_1^{\frac{m-1}{m}} + e_1 \Delta_1^{\frac{m-2}{m}} + \text{etc.} = 0,$$

$$\text{and } m\left\{F(r_1)\right\} = h_2 \Delta_2^{\frac{m-1}{m}} + e_2 \Delta_2^{\frac{m-2}{m}} + \text{etc.}$$

By §8, because r_1 is in a simple state, and $F(r_1) = 0$, the coefficients h_1, e_1, etc., are zero separately. But h_1 is clear of the surd $\Delta_1^{\frac{1}{m}}$. It therefore does not involve more than $n - 1$ distinct surds that are not roots of unity. Therefore, on the assumption on which we are proceeding, because $h_1 = 0$, $h_2 = 0$. In like manner, $e_2 = 0$, and so on. Therefore $F(r_2) = 0$.

§15. *Cor.* Let the simplified expression r_1 be the root of an equation $F(x) = 0$ whose coefficients involve certain surds $z_1^{\frac{1}{n}}, u_1^{\frac{1}{s}}$, etc., that have the same determinate values in r_1 as in $F(x)$. Then, if r_2 be a particular cognate form of R in which the surds $z_1^{\frac{1}{n}}, u_1^{\frac{1}{s}}$, etc., retain the determinate values belonging to them in r_1, r_2 is a root of the equation $F(x) = 0$. For, $F(r_1) = 0$. Therefore, by the Proposition, $F(R) = 0$. Let R, restricted by the condition that the surds $z_1^{\frac{1}{n}}, u_1^{\frac{1}{s}}$, etc., retain the determinate values belonging to them in r_1, be R'. Then $F(R') = 0$. A particular case of this is $F(r_2) = 0$. The corollary established simply means that the surds $z_1^{\frac{1}{n}}, u_1^{\frac{1}{s}}$, etc., may be taken to be rational for the purpose in hand.

§16. The simplified expression r_1 being one of the particular cognate forms of R, let

$$r_1, r_a, \text{etc.} \tag{5}$$

be the entire series of the particular cognate forms of R, not necessarily unequal to one another. Then, if the equation whose roots are the terms in (5) be $X = 0$, X is rational. In like manner, if those particular cognate forms of R, not necessarily unequal, that are obtained when certain surds $z_1^{\frac{1}{n}}, u_1^{\frac{1}{s}}$, etc., retain the determinate values belonging to them in r_1, be

$$r_1, r_e, \text{etc.} \tag{6}$$

and if the equation whose roots are the terms in (6) be $X' = 0$, X' involves only surds found in the series $z_1^{\frac{1}{n}}, u_1^{\frac{1}{s}}$, etc. This is substantially proved by Legendre in his Théorie des Nombres, §487, third edition.

§17. PROPOSITION III. The unequal particular cognate forms of R, the generic expression under which the simplified expression r_1 falls, are the roots of a rational irreducible equation; and each of the unequal particular cognate forms occurs the same number of times in the series of the cognate forms.

As in §16, let the entire series of the particular cognate forms of R be the terms in (5), the equation that has these terms for its roots being $X = 0$. By §16, X is rational. Should X not be irreducible, it has a rational irreducible factor, say $F(x)$, such that r_1 is a root of the equation $F(x) = 0$. By Prop. II., because r_1 is in a simple state, all the terms in (5) are roots of the equation $F(x) = 0$, while at the same time, because $F(x)$ is a factor of X, all the roots of the equation are terms in (5). And the equation $F(x) = 0$, being irreducible, has no equal roots. Therefore its roots are the unequal terms in (5). Should $F(x)$ not be identical with X, put

$$X = \{F(x)\}\ \{\varphi(x)\}.$$

Because X and $F(x)$ are rational, $\varphi(x)$ is rational. Then, since $\varphi(x)$ is a measure of X, and the equation $F(x) = 0$ has for its its roots the unequal roots of the equation $X = 0$, the equations $F(x) = 0$ and $\varphi(x) = 0$ have a root in common. Consequently, since $F(x)$ is irreducible, it is a measure of $\varphi(x)$. Therefore $\{F(x)\}^2$ is a measure of X. Going on in this way we ultimately get $X = \{F(x)\}^N$; which means that each of the particular cognate forms of R has its value repeated N times in the series of the particular cognate forms.

§18. *Cor.* 1. The series (6) consisting of those particular cognate forms of R in which certain surds $z_1^{\frac{1}{n}}$, $u_1^{\frac{1}{s}}$, etc., retain the determinate values belonging to them in r_1, each of the unequal terms in (6) occurs the same number of times in (6); and the unequal terms in (6) are the roots of an irreducible equation whose coefficients involve only surds found in the series $z_1^{\frac{1}{n}}$, $u_1^{\frac{1}{s}}$, etc. Should X' not be irreducible, by which in such a case is meant incapable of being broken into lower factors involving only surds occurring in X', let it have the irreducible factor X''. That is to say, X'' involves only surds occurring in X', and has itself no lower factor involving only surds that occur in X''. We may take r_1 to be a root of the equation $X'' = 0$. Then, by Cor. Prop. II., all the terms in (6) are roots of that equation, all the roots of the equation being at the same time terms in (6). And the equation $X'' = 0$ being irreducible, has no equal roots. Therefore its roots are the unequal terms in (6). Put

$X' = (X'')(X''')$. Then, by the line of reasoning followed in the Proposition, X''' has a measure identical with X''. And so on. Ultimately $X' = (X'')^N$.

§19. *Cor.* 2. If r_2, one of the particular cognate forms of R, be zero, all the particular cognate forms of R are zero. For, by the proposition, the particular cognate forms of R are the roots of a rational irreducible equation $F(x) = 0$. And r_2, one of the roots of that equation, is zero, but the only rational irreducible equation that has zero for a root is $x = 0$. Therefore $F(x) = x = 0$. In fact, in the case supposed, the simplified expression r_1 is zero, and R has no particular cognate forms distinct from r_1.

§20. PROPOSITION IV. Let N be the continued product of the distinct prime numbers n, a, etc. Let ω_1 be a primitive n^{th} root of unity, θ_1 a primitive a^{th} root of unity, and so on. Then if the equation

$$F(x) = x^d + b_1x^{d-1} + b_2x^{d-2} + \text{etc.} = 0$$

be one in which the coefficients b_1, b_2, etc., are rational functions of ω_1, θ_1, etc., and if all the primitive n^{th} roots of unity, which, when substituted for ω_1 in $F(x)$, leave $F(x)$ unaltered, be

$$\omega_1\,,\ \omega_2\,,\ \ldots\ldots,\ \omega_s\,, \tag{7}$$

the series (7) either consists of a single term or it is made up of a cycle of primitive n^{th} roots of unity,

$$\omega_1,\ \omega_1^{\lambda},\ \omega_1^{\lambda^2},\ \ldots\ldots,\ \omega_1^{\lambda^{s-1}}\ ; \tag{18}$$

that is to say, no term in (8) after the first is equal to the first, but $\omega_1^{\lambda^s} = \omega_1$. Also, if (let it be kept in view that n is prime) the cycle that contains all the primitive n^{th} roots of unity be

$$\omega_1,\ \omega_1^{\beta},\ \omega_1^{\beta^2},\ \ldots\ldots,\ \omega_1^{\beta^{n-2}}\,, \tag{9}$$

and if C_1 be the sum of the terms in the cycle (8), the form of $F(x)$ is

$$F(x) = x^d - (p_1C_1 + p_2C_2 + \ldots\ldots + p_mC_m)\,x^{d-1} + (q_1C_1 + q_2C_2 + \text{etc.})\,x^{d-2} + \text{etc.} \tag{10}$$

where each of the expressions in the series C_1, C_2, C_3, etc., is what the immediately preceding term becomes by changing ω_1 into ω_1^{β}, C_m through this change becoming C_1; and p_1, p_2, q_1, etc., are clear of ω_1.

For, assuming that there is a term ω_2 in (7) additional to ω_1, we may take ω_2 to be the first term in (9) after ω_1 that occurs in (7); and it may be considered to be $\omega_1^{\beta^m}$, which may be otherwise written ω_1^{λ}. Then, if $F(x)$ be written $\varphi(\omega_1)$, we have by hypothesis

$\varphi(\omega_1) = \varphi(\omega_1^{\lambda})$. Therefore, by §12, changing ω_1 into ω_1^{λ}, $\varphi(\omega_1^{\lambda}) = \varphi(\omega_1^{\lambda^2})$. Therefore $\varphi(\omega_1) = \varphi(\omega_1^{\lambda^2})$. And thus ultimately $\varphi(\omega_1) = \varphi(\omega_1^{\lambda^z})$, or $\varphi(\omega_1) = \varphi(\omega_1^{\beta^{mz}})$, z being any whole number positive or negative. But $\omega_1^{\lambda^z}$ includes all the terms in (8). Therefore each of these terms is a term in (7). Suppose if possible that there is a term in (7), say $\omega_1^{\beta^h}$, which does not occur in (8). Then, just as we deduced $\varphi(\omega_1) = \varphi(\omega_1^{\beta^{mz}})$ from the equation $\varphi(\omega_1) = \varphi(\omega_1^{\beta^m})$, we can, because still farther $\varphi(\omega_1) = \varphi(\omega_1^{\beta^h})$, deduce $\varphi(\omega_1) = \varphi(\omega_1^{\beta^{mz+hu}})$. Because $\omega_1^{\beta^h}$ lies outside the cycle (8), h is not a multiple of m. And it is not less than m, because $\omega_1^{\beta^m}$ is the first term in (9) after ω_1, which, when substituted for ω_1 in $\varphi(\omega_1)$, leaves $\varphi(\omega_1)$ unaltered. Therefore $h = qm + v$, where q and v are whole numbers, and v is less than m but not zero. Put

$$z = -(h+q), \text{ and } u = m+1 \therefore mz+hu = v \therefore \varphi(\omega_1) = \varphi(\omega_1^{\beta^v});$$

which, because v is less than m but not zero, and $\omega_1^{\beta^m}$ is the first term in (9) after ω_1 which, when substituted for ω_1 in $\varphi(\omega_1)$, leaves $\varphi(\omega_1)$ unaltered, is impossible. Hence, no term in (7) lies outside the cycle (8), while it has also been shown that all the terms in (8) are terms in (7). Therefore the terms in (7) are identical with those constituting the cycle (8). We have now to determine the form of $F(x)$. The expressions, C_1, C_2, etc., taken together, are the sum of the terms in (9). Therefore $\quad C_1 + C_2 + \ldots + C_m = -1. \quad$ (11)
Because (9) contains all the primitive n^{th} roots of unity, we may put

$$F(x) = x^d - \{p + (p+p_1)\,\omega_1 + (p+p_2)\,\omega_1^{\beta} + \text{etc.}\}\,x^{d-1} + \text{etc.}; \quad (12)$$

where p, p_1, etc., are clear of ω_1. But $F(x)$ remains unaltered when ω_1 is changed into $\omega_1^{\beta^m}$. Therefore

$$F(x) = x^d - \{p + (p+p_1)\,\omega_1^{\beta^m} + \text{etc.}\}\,x^{d-1} + \text{etc.} \quad (13)$$

Therefore, equating the coefficients of x^{d-1} in (12) and (13),

$$(p - p_1) + \ldots + (p_{m+1} - p_1)\,\omega_1^{\beta^m} + \text{etc.} = 0.$$

Here, by §13, the coefficients of the different powers of ω_1 have all the same value. And one of them, $p - p_1$, is zero. Therefore

$p_{m+1} = p_1$. That is to say, the coefficient of $\omega_1^{\beta^m}$ or ω_1^{λ} is the same as that of ω_1. In like manner the coefficients of all the terms in (8) are the same. Therefore one group of the terms that together make up the coefficient of x^{d-1} in (12) is properly represented by $-(p + p_1)C_1$. In the same way another group is properly represented by $-(p + p_2)C_2$, and so on. Hence

$$F(x) = x^d - \{p + (p + p_1)\,C_1 + (p + p_2)\,C_2 + \text{etc.}\}x^{d-1} + \text{etc.}$$

And by (11) this is equivalent to (10). The form of $F(x)$ has been deduced on the assumption that the series (7) contains more than one term; but, should the series (7) consist of a single term, the result obtained would still hold good, only in that case each of the expressions C_1, C_2, etc., would be a primitive n^{th} root of unity.

§21. A simplified expression will not cease to be in a simple state, if we suppose that any surd that can be eliminated from it, without the introduction of any new surd, has been eliminated.

§22. PROPOSITION V. In the simplified expression r_1, one of the particular cognate forms of R, modified according to §21, let the surd $\varDelta_1^{\frac{1}{m}}$ of the highest rank be not a root (see §1) of unity. Then, if the particular cognate forms of R obtained by changing $\varDelta_1^{\frac{1}{m}}$ in r_1 successively into the different m^{th} roots of the determinate base $\varDelta_1$, be

$$r_1\,,\ r_2\,,\ \ldots\ldots\,,\ r_m, \tag{14}$$

these terms are all unequal.

For the terms in (14) are all the particular cognate forms of R obtained when we allow all the surds in r_1 except $\varDelta_1^{\frac{1}{m}}$ to retain the determinate values belonging to them in r_1. Therefore, by Cor. 1, Prop. III., each of the unequal terms in (14) has its value repeated the same number of times in that series. Let u be the number of the unequal terms in (14), and let each occur c times. Then $uc = m$. Suppose if possible that $u = 1$. This means that all the terms in (14) are equal. Therefore, r_1 being the expression (1),

$$mr_1 = r_1 + r_2 + \ldots\ldots + \text{etc.} = g_1.$$

Therefore the surd $\varDelta_1^{\frac{1}{m}}$ can be eliminated from r_1 without the introduction of any new surd; which, by §21, is impossible. Therefore u is not unity. But, by §1, m is a prime number. And $m = uc$. Therefore $c = 1$ and $u = m$. This means that all the terms in (14) are unequal.

§23. *Cor.* 1. Let r_{a+1} be any one of the particular cognate forms of R; and let $\Delta_{a+1}^{\frac{1}{m}}$, h_{a+1}, etc., be respectively what $\Delta_1^{\frac{1}{m}}$, h_1, etc., become in passing from r_1 to r_{a+1}. Also let the m particular cognate forms of R, obtained by changing $\Delta_{a+1}^{\frac{1}{m}}$ in r_{a+1} successively into the different m^{th} roots of Δ_{a+1}, be

$$r_{a+1}\,,\ r_{a+2}\,,\ \ldots\ldots\,,\ r_{a+m}\,. \tag{15}$$

These terms are all unequal. For, because $\Delta_1^{\frac{1}{m}}$ is a principal surd in r_1, and r_2 is what r_1 becomes when $\Delta_1^{\frac{1}{m}}$ is changed into a surd whose value is $\omega_1\Delta_1^{\frac{1}{m}}$, ω_1 being a primitive m^{th} root of unity. the view may be taken that r_2 involves no surds additional to those found in r_1, except the primitive m^{th} root of unity ω_1. Therefore $r_1 - r_2$ involves no surds distinct from primitive m^{th} roots of unity that are not found in the simplified expression r_1. Therefore $r_1 - r_2$ is in a simple state. Let r_{a+2} be what r_{a+1} becomes by changing $\Delta_{a+1}^{\frac{1}{m}}$ into $\omega_1\Delta_{a+1}^{\frac{1}{m}}$. Then $r_{a+1} - r_{a+2}$ is a particular cognate form of the generic expression under which the simplified expression $r_1 - r_2$ falls. Therefore $r_{a+1} - r_{a+2}$ cannot be zero; for, if it were, $r_1 - r_2$ would, by Cor. 2, Prop. III., be zero; which, by the proposition, is impossible. Hence, the first two terms in (15) are unequal. In like manner all the terms in (15) are unequal.

§24. *Cor.* 2. Let $X_1 = 0$ be the equation whose roots are the terms in (14). When X_1 is modified according to §21, it is, by §16, clear of the surd $\Delta_1^{\frac{1}{m}}$. Should it involve any surds that are not roots of unity, take $z_1^{\frac{1}{c}}$ a surd of the highest rank not a root of unity in X_1; and, when $z_1^{\frac{1}{c}}$ is changed successively into the different c^{th} roots of the determinate base z_1, let

$$X_1\,,\ X_1'\,,\ X_1''\,,\ \ldots\ldots\,,\ X_1^{(c-1)}, \tag{16}$$

be respectively what X_1 becomes. Any term in (16), as X_1', being selected, the m roots of the equation $X_1' = 0$ are unequal particular

cognate forms of R. For, $z_2^{\frac{1}{c}}$ being a c^{th} root of z_1 distinct from $z_1^{\frac{1}{c}}$, let r_{a+1} be what r_1 becomes when $z_1^{\frac{1}{c}}$ becomes $z_2^{\frac{1}{c}}$; the expressions $\Delta_1^{\frac{1}{m}}$, h_1, etc., at the same time becoming $\Delta_{a+1}^{\frac{1}{m}}$, h_{a+1}, etc. Then we may put

$$X_1 = x^m + (bz_1^{\frac{c-1}{c}} + dz_1^{\frac{c-2}{c}} + \text{etc.})\, x^{m-1} + \text{etc.}; \qquad (17)$$

where b, d, etc., are clear of $z_1^{\frac{1}{c}}$. Therefore, because r_1 is a root of the equation $X_1 = 0$,

$$\left\{ \frac{1}{m} (h_1 \Delta_1^{\frac{m-1}{m}} + \text{etc.}) \right\}^m$$
$$+ (bz_1^{\frac{c-1}{c}} + dz_1^{\frac{c-2}{c}} + \text{etc.}) \left\{ \frac{1}{m} (h_1 \Delta_1^{\frac{m-1}{m}} + \text{etc.}) \right\}^{m-1} + \text{etc.} = 0.$$

All the surds in this equation occur in the simplified expression r_1. Therefore, by Prop. II.,

$$\left\{ \frac{1}{m} (h_{a+1} \Delta_{a+1}^{\frac{m-1}{m}} + \text{etc.}) \right\}^m$$
$$+ (bz_2^{\frac{c-1}{c}} + dz_2^{\frac{c-2}{c}} + \text{etc}) \left\{ \frac{1}{m} (h_{a+1} \Delta_{a+1}^{\frac{m-1}{m}} + \text{etc.}) \right\}^{m-1} + \text{etc.} = 0.$$

Therefore $\frac{1}{m} (h_{a+1} \Delta_{a+1}^{\frac{m-1}{m}} + \text{etc.})$ or r_{a+1} is a root of the equation

$$X_1' = x^m + (bz_2^{\frac{c-1}{c}} + \text{etc.})\, x^{m-1} + \text{etc.} = 0. \qquad (18)$$

Therefore also, by Cor. Prop. II., all the terms in (15) are roots of that equation. And, by Cor. 1, the terms in (15) are all unequal. Therefore the equation $X_1' = 0$ has m unequal particular cognate forms of R for its roots.

§25. *Cor.* 3. No two of the expressions in (16), as x_1 and X_1', are identical with one another. For, in order that X_1 and X_1' might be identical, the coefficients of the several powers of x in X_1 would need to be equal to those of the corresponding powers of x in X_1'; but, if

one of the coefficients of X_1 be selected in which $z_1^{\frac{1}{c}}$ is present, this coefficient can be shown to be unequal to the corresponding coefficient in X_1' in the same way in which the terms in (15) were proved to be all unequal.

§26. *Cor.* 4. Any two of the terms in (16), as X_1 and X_1'. being selected, the equations $X_1 = 0$ and $X_1' = 0$ have no root in common. For, suppose, if possible, that these equations have a root in common. Taking the forms of X_1 and X_1' in (17) and (18), since r_1 is a root of the equation $X_1' = 0$,

$$r_1^m + (bz_2^{\frac{c-1}{c}} + \text{etc.})\, r_1^{m-1} + \text{etc.} = 0. \tag{19}$$

All the surds in this equation except $z_2^{\frac{1}{c}}$ occur in r_1. It is impossible that $z_2^{\frac{1}{c}}$ can occur in r_1; for, $z_1^{\frac{1}{c}}$ occurs in r_1; and $z_2^{\frac{1}{c}} = \theta_1 z_1^{\frac{1}{c}}$, θ_1 being a primitive c^{th} root of unity; but this equation, if both $z_1^{\frac{1}{c}}$ and $z_2^{\frac{1}{c}}$ occurred in r_1, would be of the inadmissible type (3). Since $z_2^{\frac{1}{c}}$ does not occur in r_1, it is a principal (see §2) surd in (19). We may, therefore, keeping in view that r_1 is the expression (1) in which $\Delta_1^{\frac{1}{m}}$ is a principal surd, arrange (19) thus,

$$\varphi\,(\Delta_1^{\frac{1}{m}}) = \Delta_1^{\frac{m-1}{m}}\,(p_1 z_2^{\frac{c-1}{c}} + p_2 z_2^{\frac{c-2}{c}} + \text{etc.})$$
$$+ \Delta_1^{\frac{m-2}{m}}\,(q_1 z_2^{\frac{c-1}{c}} + q_2 z_2^{\frac{c-2}{c}} + \text{etc.}) + \text{etc.} = 0\,; \tag{20}$$

where p_1, q_1, etc., are clear of $z_2^{\frac{1}{c}}$. Then, ω_1 being a primitive m^{th} root of unity such that, by changing $\Delta_1^{\frac{1}{m}}$ into the m^{th} root of Δ_1 whose value is $\omega_1 \Delta_1^{\frac{1}{m}}$, r_1 becomes r_2,

$$\varphi\left(\omega_1 \Delta_1^{\frac{1}{m}}\right) = \omega_1^{m-1} \Delta_1^{\frac{m-1}{m}} \left(p_1 z_2^{\frac{c-1}{c}} + \text{etc.}\right)$$
$$+ \omega_1^{m-2} \Delta_1^{\frac{m-1}{m}} \left(q_1 z_2^{\frac{c-1}{c}} + \text{etc.}\right) + \text{etc.} \qquad (21)$$

The coefficients of the several powers of $\Delta_1^{\frac{1}{m}}$ in $\varphi\left(\Delta_1^{\frac{1}{m}}\right)$ cannot be all zero; for, if they were, we should have, from (21), $\varphi\left(\omega_1 \Delta_1^{\frac{1}{m}}\right) = 0$. This means that r_2 is a root of the equation $X_1' = 0$. But in like manner all the terms in (14) would be roots of that equation, and X_1' would be identical with X; which, by Cor. 3, is impossible. Since the coefficients of the different powers of $\Delta_1^{\frac{1}{m}}$ in $\varphi\left(\Delta_1^{\frac{1}{m}}\right.$ are not all zero, the equation (20) gives us, by §5, $\omega \Delta_1^{\frac{1}{m}} = l_1$, ω being an m^{th} root of unity, and l_1 involving only surds in $\varphi\left(\Delta_1^{\frac{1}{m}}\right)$exclusive of $\Delta_1^{\frac{1}{m}}$. In l_1 we may conceive $z_2^{\frac{1}{c}}$ changed into $\theta_1 z_1^{\frac{1}{c}}$. Then l_1 involves only surds distinct from $\Delta_1^{\frac{1}{m}}$, all of them except the primitive c^{th} root of unity θ_1 being surds that occur in r_1. This makes the equation $\omega \Delta_1^{\frac{1}{m}} = l_1$ of the inadmissible type (3). Hence the equations $X_1 = 0$ and $X_1' = 0$ have no root in common.

§27. *Cor.* 5. Let X_2 be the continued product of the terms in (16). Then X_2, modified according to §21, is clear of $z_1^{\frac{1}{c}}$, in the same way in which X_1 is clear of $\Delta_1^{\frac{1}{m}}$. Also since, by Cor. 2, each of the equations $X_1 = 0$, $X_1' = 0$, etc., has m unequal particular cognate forms of R for its roots, and since, by Cor. 4, no two of these equations have a root in common, the mc roots of the equation $X_2 = 0$ are unequal particular cognate forms of R.

§28. Proposition VI. Let the simplified expression r_1, modified according to §21, be a root of the rational irreducible equation of the N^{th} degree, $F(x) = 0$. Then if $\Delta_1^{\frac{1}{m}}$, not a root of unity, be a surd of the highest rank in r_1, N is a multiple of m. But if r_1 involve only surds that are roots of unity, one of them being the primitive n^{th} root of unity, N is a multiple of a measure of $n - 1$..

First, let $\Delta_1^{\frac{1}{m}}$, not a root of unity, be a surd of the highest rank in r_1. Taking the expression (1) to be r_1, let X_1 be formed as in §24, and let it be modified according to §21. It is clear of the surd $\Delta_1^{\frac{1}{m}}$. Should it involve a surd that is not a root of unity, let X_2 be formed as in §27. Setting out from r_1 we arrived by one step at X_1, an expression clear of $\Delta_1^{\frac{1}{m}}$, and such that the roots of the equation $X_1 = 0$ are unequal particular cognate forms of R. A second step brought us to X_2, an expression clear of the additional surd $z_1^{\frac{1}{c}}$, and such that the mc roots of the equation $X_2 = 0$ are unequal particular cognate forms of R. Thus we can go on till, in the series X_1, X_2, etc., we reach a term X_e into which no surds enter that are not roots of unity, the $mc \ldots. l$ roots of the equation $X_e = 0$ being unequal particular cognate forms of R. Should X_e modified according to §21, not be rational, its form, by Prop. IV., putting d for $mc \ldots. l$, is

$$X_e = x_d - (p_1C_1 + \ldots. + p_mC_m)x^{d-1} + (q_1C_1 + \ldots. + q_mC_m)x^{d-2} + \text{etc.};$$

where, one of the roots occurring in X_e being the primitive n^{th} root of unity ω_1, the coefficients p_1, q_1, etc., are clear of ω_1; and C_1 is the sum of the cycle of primitive n^{th} roots of unity (8) containing s or $\dfrac{n-1}{m}$ terms; and, the cycle (9) containing all the primitive n^{th} roots of unity, the change of ω_1 into ω_1^{β} causes C_1 to become C_2, and C_2 to become C_3, and so on, C_m becoming C_1. As was explained at the close of §20, the cycle (8) may be reduced to a single term, which is then identical with C_1. It will also not be forgotten that the roots of unity such as the n^{th} here spoken of are, according to §1, subject to the condition that the numbers such as n are prime. When C_1 in X_e is changed successively into C_1, C_2, etc., let X_e become

$$X_e,\ X_e',\ X_e'',\ \ldots.,\ X_e^{(m-1)} \tag{22}$$

If X_{e+1} be the continued product of the terms in (22), the dm roots of the equation $X_{e+1} = 0$ can be shown to be unequal particular cognate forms of R. For, no two terms in (22) as X_e and X'_e are identical; because, if they were, X_e would remain unaltered by the change of ω_1 into ω_1^β; which, by Prop. IV., because ω_1^β is not a term in the cycle (8), is impossible. It follows that no two of the equations $X_e = 0$, $X'_e = 0$, etc., have a root in common. For, if the equations $X_e = 0$, and $X'_e = 0$ had a root in common, since X_e and X'_e are not identical, X_e would have a lower measure involving only surds found in X_e, because the surds in X'_e are the same with those in X_e. Let $\varphi(x)$ be this lower measure of X_e, and let r_1 be a root of the equation $\varphi(x) = 0$. Then, by Cor. Prop. II., all the d roots of the equation $X_e = 0$ are roots of the equation $\varphi(x) = 0$; which is impossible. In the same way it can be proved that no equation in the series $X_e = 0$, $X'_e = 0$, etc., has equal roots. Since no one of these equations has equal roots, and no two of them have a root in common, the dm roots of the equation $X_{e+1} = 0$ are unequal particular cognate forms of R. Also X_{e+1}, modified according to §21, is clear of the primitive n^{th} roots of unity. Should X_{e+1} not be rational, we can deal with it as we did with X_e. Going on in this way, we ultimately reach a *rational* expression X_z such that the $dm \ldots g$ roots of the equation $X_z = 0$ are unequal particular cognate forms of R. This equation must be identical with the equation $F(x) = 0$ of which r_1 is a root. For, by Prop. III., the equation $F(x) = 0$ has for its roots the unequal particular cognate forms of R. Therefore, because the roots of the equation $X_z = 0$ are all unequal and are at the same time particular cognate forms of R, X_z must be either a lower measure of $F(x)$ or identical with $F(x)$. But $F(x)$, being irreducible, has no lower measure. Therefore X_z is identical with $F(x)$. Therefore, the equation $F(x) = 0$ being the N^{th} degree, $N = mc \ldots lm \ldots g$. Hence N is a multiple of m. This is the result arrived at when r_1 involves a surd of the highest rank $\Delta_1^{\frac{1}{m}}$ not a root of unity. Should r_1 involve no surds except roots (see §1) of unity, we should then have set out from X_e regarded as identical with $x - r_1$. The result would have been $N = m \ldots g$. Therefore N is a multiple of m; and, because m is here the number of cycles of s terms each, that make up the series of the primitive n^{th} roots of unity, $ms = n - 1$. Therefore N is a multiple of a measure of $n - 1$.

§29. *Cor.* Let N be a prime number. Then, if r_1 involve a surd of the highest rank $\Delta_1^{\frac{1}{m}}$ not a root (see §1) of unity, $N = m$; for,

the series of integers m, c, etc., of which N is the continued product, is reduced to its first term. If r_1 involve only surds that are roots of unity, $n-1$ is a multiple of N; for $N=m \ldots . g$; therefore, because N is prime, it is equal to m; but $ms=n-1$; therefore $n-1=sN$.

The Solvable Irreducible Equation of the m^{th} Degree, m Prime.

§30. The principles that have been established may be illustrated by an examination of the solvable irreducible rational equation of the m^{th} degree $F(x)=0$, m being prime. Two cases may be distinguished, though it will be found that the roots can in the two cases be brought under a common form; the one case being that in which the simplified root r_1 is, and the other that in which it is not, a rational function of roots of unity, that is, according to §1, of roots of unity having the denominators of their indices prime numbers. The equation $F(x)=0$ may be said to be in the former case *of the first class*, and in the latter *of the second class.*

The Equation $F(x)=0$ of the First Class.

§31. In this case, by Cor. Prop. VI., r_1 being modified according to §21, if one of the roots involved in r_1 be the primitive n^{th} root of unity ω_1, $n-1$ is a multiple of m. Also the expression written X_s in Prop. VI. is reduced to $x-r_1$, so that

$$r_1 = p_1C_1 + p_2C_2 + \ldots . + p_mC_m .$$

The m roots of the equation $F(x)=0$ being r_1, r_2, etc, we must have

$$\left.\begin{aligned} r_1 &= p_1 C_1 + p_2C_2 + \ldots . + p_mC_m, \\ r_2 &= p_mC_1 + p_1C_2 + \ldots . + p_{m-1}C_m, \\ &\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ r_m &= p_2 C_1 + p_3C_2 + \ldots . + p_1C_m . \end{aligned}\right\} \tag{23}$$

For, by Prop. II., because r_1 is a root of the equation $F(x)=0$, all the expressions on the right of the equations (23) are roots of that equation. And no two of these expressions are equal to one another. For, take the first two. If these were equal, we should have $(p_m - p_1) C_1 + (p_1 - p_2) C_2 +$ etc. $=0$. Therefore, by §13, each of the terms $p_m - p_1$, $p_1 - p_2$, etc., is zero. This makes p_1, p_2, etc., all equal to one another. Therefore $r_1 = -p_1$; so that the primitive n^{th} root of unity is eliminated from r_1; which, by §21, is impossible. Hence the values of the m roots of the equation $F(x)=0$ are those given in (23).

§32. Let r_1' be one of the particular cognate forms of the generic expression R under which the simplified expression r_1 falls. Then, because, by Prop. II., all the particular cognate forms of R are roots of the equation $F(x) = 0$, r_1' is equal to one of the m terms r_1, r_2, etc., say to r_s. I will now show that the changes of the surds involved that cause r_1 to become r_1', whose value is r_s, cause r_2 to receive the value r_{s+1}, and r_3 to receive the value r_{s+2}, and so on. This may appear obvious on the face of the equations (23); but, to prevent misunderstanding, the steps of the deduction are given. Any changes made in r_1 must transform C_1 into C_s, one of the m terms C_1, C_2, etc. In passing from r_1 to r_1', while C_1 becomes C_s, let r_2 become r_2', and p_1 become p_1', and p_2 become p_2', and so on. The change that causes C_1 to become C_s transforms C_2 into C_{s+1}, and C_3 into C_{s+2}, and so on. Therefore, it being understood that p_{m+1}, C_{m+1}, etc., are the same as p_1, C_1, etc., respectively,

$$r_1' = p_1' C_s + p_2' C_{s+1} + \text{etc.},$$

$$\text{and } r_2' = p_m' C_s + p_1' C_{s+1} + \text{etc.};$$

which may be otherwise written

$$\left.\begin{aligned} r_1' &= p'_{m+2-s} C_1 + p'_{m+3-s} C_2 + \text{etc.}, \\ r_2' &= p'_{m+1-s} C_1 + p'_{m+2-s} C_2 + \text{etc.} \end{aligned}\right\} \qquad (24)$$

Therefore, form (24) and (23),

$$C_1(p'_{m+2-s} - p_{m+2-s}) + C_2(p'_{m+3-s} - p_{m+3-s}) + \text{etc.} = 0.$$

Therefore, by §13, $p'_{m+2-s} = p_{m+2-s}$, $p'_{m+3-s} = p_{m+3-s}$, etc.

Hence the second of the equations (24) becomes

$$r_2' = p_{m+1-s} C_1 + p_{m+2-s} C_2 + \text{etc.} = r_{s+1}.$$

Thus r_2 is transformed into r_{s+1}. In like manner r_3 receives the value r_{s+2}, and so on.

§33. By Cor. Prop. VI., the primitive n^{th} root of unity being one of those involved in r_1, $n - 1$ is a multiple of m. In like manner, if the primitive a^{th} root of unity be involved in r_1, $a - 1$ is a multiple of m, and so on. Therefore, if t_1 be the primitive m^{th} root of unity, t_1 is distinct from all the roots involved in r_1.

§34. From this it follows that, if the circle of roots r_1, r_2, ..., r_m, be arranged, beginning with r_c, in the order r_c, r_{c+1}, r_{c+2}, etc., and again, beginning with r_s, in the order r_s, r_{s+1}, r_{s+2}, etc., and if, t_1^a being one of the primitive m^{th} roots of unity,

$$r_c + r_{c+1} t_1 + r_{c+2} t_1^2 + \text{etc.} = r_s + r_{s+1} t_1^a + r_{s+2} t_1^{2a} + \text{etc.} \quad (25)$$

$r_c = r_s$. It is understood that in the series r_c, r_{c+1}, etc., when r_m is reached, the next in order is r_1, so that r_{m+1} is the same as r_1, and so on. In like manner r_{s+1} is the same as r_1, and so on. Since r_1, r_2, etc., do not involve the primitive m^{th} root of unity t_1, we can, by §12, substitute for t_1 in (25) successively the different primitive m^{th} roots of unity. Let this be done. Then, by addition,

$mr_c - (r_1 + r_2 + \text{etc.}) = mr_s - (r_1 + r_2 + \text{etc.})$. Therefore $r_c = r_s$.

§35. Proposition VII. Putting

$$\left.\begin{aligned}
\Delta_1^{\frac{1}{m}} &= r_1 + t_1 r_2 + t_1^2 r_3 + \ldots \quad + t_1^{m-1} r_m, \\
\Delta_2^{\frac{1}{m}} &= r_1 + t_1^2 r_2 + t_1^4 r_3 + \ldots\ldots + t_1^{2(m-1)} r_m, \\
&\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\
\Delta_{m-1}^{\frac{1}{m}} &= r_1 + t_1^{-1} r_2 + t_1^{-2} r_3 + \ldots\ldots + t_1 r_m,
\end{aligned}\right\} \quad (26)$$

the terms, $\qquad \Delta_1, \Delta_2, \Delta_3, \ldots\ldots, \Delta_{m-1}, \qquad (27)$

are the roots of a rational irreducible equation of the $(m-1)^{\text{th}}$ degree $\varphi(x) = 0$, which may be said to be *auxiliary* to the equation $F(x) = 0$.

For, let Δ be the generic expression of which Δ_1 is a particular cognate form; and let Δ' denote any one indifferently of the $m-1$ particular cognate forms of Δ in (27). Because, by §33, the primitive m^{th} root of unity does not enter into r_1, r_2, etc., no changes made in r_1, r_2, etc., affect t_1. Also, by §32, if r_1 becomes r_z, r_2 becomes r_{z+1}, r_3 becomes r_{z+2}, and so on. Therefore the expression

$$(r_z + tr_{z+1} + t^2 r_{z+2} + \text{etc.})^m,$$

contains all the particular cognate forms of Δ; where z may be any number in the series $1, 2, \ldots\ldots, m-1$; and t denotes any one indifferently of the primitive m^{th} roots of unity. But this is equal to

$$\left\{ t^{1-z} (r_1 + tr_2 + t^2 r_3 + \text{etc.}) \right\}^m \text{ or } \Delta'.$$

The conclusion established means that all the differences of value that can present themselves in the particular cognate forms of Δ must arise

from the different values of t that are taken in Δ', while the expressions r_1, r_2, etc., remain unaltered. And t has not more than $m - 1$ values. Hence there are not more than $m - 1$ unequal particular cognate forms of Δ. But the $m - 1$ forms obtained by taking the different values of t in Δ' are all unequal. For, selecting t_1 and t_1^a, two distinct values of t, suppose if possible that

$$(r_1 + t_1 r_2 + \text{etc.})^m = (r_1 + t_1^a r_2 + \text{etc.})^m$$

$$\therefore t_1^s (r_1 + t_1 r_2 + \text{etc.}) = r_1 + t_1^a r_2 + \text{etc.},$$

s being a whole number. This may be written

$$r_{m+1-s} + r_{m+2-s} t_1 + \text{etc.} = r_1 + t_1^a r_2 + \text{etc.} \qquad (28)$$

Therefore, by §34, $r_{m+1-s} = r_1$. This means, since all the m terms r_1, r_2, etc., are unequal, that $s = 0$. Hence (28) becomes

$$r_1 + r_2 t_1 + \text{etc.} = r_1 + r_2 t_1^a + \text{etc.}$$

Therefore

$$r_2 + r_3 t_1^a + \text{etc.} = r_2 t_1^{1-a} + r_3 t_1^{2-a} + \text{etc.}$$
$$= r_{a+1} + r_{a+2} t_1 + \text{etc.}$$

Therefore, by §35, $r_2 = r_{a+1}$. Therefore, because all the m terms r_1, r_2, etc., are unequal, $a = 1$; which, because t_1 and t_1^a were supposed to be distinct primitive m^{th} roots of unity, is impossible. Therefore no two of the terms in (27) are equal to one another. And it has been proved that there is no particular cognate form of Δ which is not equal to a term in (27). Therefore the terms in (27) are the unequal particular cognate forms of Δ. Therefore, by Prop. III., they are the roots of a rational irreducible equation.

§36. Proposition VIII. The roots of the equation $\varphi(x) = 0$ auxiliary (see §35) to $F(x) = 0$ are rational functions of the primitive m^{th} root of unity.

For, let the value of Δ_1, obtained from (26), and modified according to §21, be

$$\Delta_1 = k_1 + k_2 t_1 + k_3 t_1^2 + \ldots\ldots + k_m t_1^{m-1},$$

where k_1, k_2, etc., are clear of t_1. Suppose if possible that k_1, k_2, etc., are not rational. We may take the primitive n^{th} root of unity ω_1 to be present in these coefficients. But ω_1 occurs in r_1, r_2, etc., and therefore also in Δ_1, only in the expressions C_1, C_2, etc. Therefore $\Delta_1 = d_1 C_1 + \ldots\ldots + d_m C_m$; where d_1, etc., are clear of ω_1. The coefficients d_1, d_2, etc., cannot all be equal; for this would make $\Delta_1 = - d_1$; which, by §21, is impossible. Hence m unequal

values of the generic expression Δ are obtained by changing C_1 successively into C_1; C_2, etc., namely,

$$d_1 C_1 + d_2 C_2 + \dots + d_m C_m,$$
$$d_m C_1 + d_1 C_2 + \dots + d_{m-1} C_m,$$
$$\dots\dots\dots\dots\dots\dots\dots\dots$$
$$d_2 C_1 + d_3 C_2 + \dots + d_1 C_m.$$

To show that these expressions are all unequal, take the first two. If these were equal, we should have

$$(d_m - d_1) C_1 + (d_1 - d_2) C_2 + \text{etc.} = 0.$$

Therefore, by §13, $d_m - d_1 = 0$, $d_1 - d_2 = 0$, and so on; which, because d_1, d_2, etc., are not all equal to one another, is impossible. Since then Δ has at least m unequal particular cognate forms, Δ_1 is, by Prop. III., the root of a rational irreducible equation of a degree not lower than the m^{th}; which, by Prop. VII., is impossible. Therefore k_1, k_2, etc., are rational. Hence each of the expressions in (27) is a rational function of t_1.

§37. *Cor.* Any expression of the type $k_1 + k_2 t_1 + k_3 t_1^2 +$ etc., which is such that all the unequal particular cognate forms of the generic expression under which it falls are obtained by substituting for t_1 successively the different primitive m^{th} roots of unity, while k_1, k_2, etc., remain unaltered, is a rational function of t_1. For, in the Proposition, Δ_1 or $k_1 + k_2 t_1 +$ etc. was shown to be a rational function of t_1, the conclusion being based on the circumstance that Δ_1 satisfies the condition specified.

§38. Proposition IX. If g be the sum of the roots of the equation $F(x) = 0$,

$$r_2 = \frac{1}{m}\Big(g + \Delta_1^{\frac{1}{m}} + a_1 \Delta_1^{\frac{2}{m}} + b_1 \Delta_1^{\frac{3}{m}} + \dots$$
$$+ e_1 \Delta_1^{\frac{m-2}{m}} + h_1 \Delta_1^{\frac{m-1}{m}}\Big); \tag{29}$$

For, z being one of the whole numbers, 1, 2, ..., $m - 1$, put

$$p_z = (r_1 + t_1^z r_2 + t_1^{2z} r_3 + \text{etc.})(r_1 + t_1 r_2 + t_1^2 r_3 + \text{etc.})^{-z}. \tag{30}$$

Multiply the first of its factors by t_1^{-z} and the second by t_1^z. Then

$$p_z = (r_2 + t_1^z r_3 + t_1^{2z} r_4 + \text{etc.})(r_2 + t_1 r_3 + t_1^2 r_4 + \text{etc.})^{-z}. \tag{31}$$

Hence p_z does not alter its value when we change r_1 into r_2, r_2 into r_3, and so on. In like manner it does not alter its value when we

change r_1 into r_a, r_2 into r_{a+1}, and so on. Therefore, by §33, p_z is not changed by any alterations that may be madé in r_1, r_2, etc., while t_1 remains unaltered. Consequently, if p_z be a particular cognate form of P, all the unequal particular cognate forms of P are obtained by substituting for t_1 successively in p_z the different primitive m^{th} roots of unity, while r_1, r_2, etc., remain unaltered. Therefore, by Cor., Prop. VIII., p_z is a rational function of t_1. When $z = 2$, let $p_z = a_1$; when $z = 3$, let $p_z = b_1$, and so on. Then, from (26) and (30), $\Delta_2^{\frac{1}{m}} = a_1 \Delta_1^{\frac{2}{m}}$, $\Delta_3^{\frac{1}{m}} = b_1 \Delta_1^{\frac{3}{m}}$ and so on. But, from (27), since g is the sum of the roots of the equation $F(x) = 0$,

$$r_1 = \frac{1}{m}\left(g + \Delta_1^{\frac{1}{m}} + \Delta_2^{\frac{1}{m}} + \ldots + \Delta_{m-1}^{\frac{1}{m}}\right).$$

By putting $a_1 \Delta_1^{\frac{2}{m}}$ for $\Delta_2^{\frac{1}{m}}$, $b_1 \Delta_1^{\frac{3}{m}}$ for $\Delta_3^{\frac{1}{m}}$ and so on, this becomes (29). Because a_1, b_1, etc., are rational functions of t_1, while Δ_1, the root of a rational irreducible equation of the $(m-1)^{\text{th}}$ degree, is also a rational function of t_1, the coefficients a_1, b_1, etc., involve no surd that is not subordinate to $\Delta_1^{\frac{1}{m}}$.

§39. Proposition X. If the prime number m be odd, the expressions

$$\Delta_1^{\frac{1}{m}} \Delta_{m-1}^{\frac{1}{m}}, \quad \Delta_2^{\frac{1}{m}} \Delta_{m-2}^{\frac{1}{m}}, \quad \ldots, \quad \Delta_{\frac{m-1}{2}}^{\frac{1}{m}} \Delta_{\frac{m+2}{m}}^{\frac{1}{m}}, \qquad (32)$$

are the roots of a rational equation of the $\left(\frac{m-1}{2}\right)^{\text{th}}$ degree.

By §32, when r_1, is charged into r_z, r_2 becomes r_{z+1}, r_3 becomes r_{z+2}, and so on. Hence the terms $r_1 r_2$, $r_2 r_3$, ... $r_m r_1$, form a cycle, the sum of the terms in which may be denoted by the symbol Σ_2^1. In like manner the sum of the terms in the cycle $r_1 r_3$, $r_2 r_4$, ..., $r_m r_2$, may be written Σ_3^1. And so on. In harmony with this notation, the sum of the m terms r_1^2, r_2^2, etc., may be written Σ_1^1. Now r_1 can only be changed into one of the terms r_1, r_2, etc.; and we have seen that, when it becomes r_z, r_2 becomes r_{z+1}, and so on. Such changes leave the cycle $r_1 r_2$, $r_2 r_3$, etc., as a whole unaltered.

Therefore, by Prop. III., Σ_2^1 is the root of a simple equation, or has a rational value. In like manner each of the expressions

$$\Sigma_1^1 , \Sigma_2^1 , \Sigma_3^1 , \ldots , \Sigma_m^2 , \qquad (33)$$

has a rational value. From (26), by actual multiplication,

$$\Delta_1^{\frac{1}{m}} \Delta_{m-1}^{\frac{1}{m}} = \Sigma_1^1 + (\Sigma_2^1)\, t_1 + (\Sigma_3^1)\, t_1^2 + \text{etc.}$$

But Σ_2^1, Σ_3^1, etc., are respectively identical with Σ_m^1, Σ_{m-1}^1, etc. Therefore

$$\Delta_1^{\frac{1}{m}} \Delta_{m-1}^{\frac{1}{m}} = \Sigma_1^1 + (\Sigma_2^1)(t_1 + t_1^{-1}) + (\Sigma_3^1)(t_1^2 + t_1^{-2}) + \text{etc.} \qquad (34)$$

Hence, since the terms in (33) are all rational, and since the terms in (32) are respectively what $\Delta_1^{\frac{1}{m}} \Delta_{m-1}^{\frac{1}{m}}$ becomes by changing t_1 successively into the $\frac{m-1}{2}$ terms t_1, t_1^2, etc., the terms in (32) are the roots of a rational equation of the $\left(\frac{m-1}{2}\right)^{\text{th}}$ degree.

§40. For the solution of the equation $x^n - 1 = 0$, n being a prime number such that m is a prime measure of $n - 1$, it is necessary to obtain the solution of the equation of the m^{th} degree which has for one of its roots the sum of the $\frac{n-1}{m}$ terms in a cycle of primitive n^{th} roots of unity. This latter equation will be referred to as the *reducing Gaussian equation* of the m^{th} degree to the equation

$$x^n - 1 = 0 .$$

§41. Proposition XI. When the equation $F(x) = 0$ is the reducing Gaussian (see §40) of the m^{th} degree to the equation $x^n - 1 = 0$, each of the $\frac{m-1}{2}$ expressions in (32) is equal to n.

Let the sum of the primitive n^{th} roots of unity forming the cycle (8), which sum has in preceding sections been indicated by the symbol C_1, be the root r_1 of the equation $F(x) = 0$. This implies, since s is the number of the terms in (8), that $ms = n - 1$. Let us reason first on the assumption that the cycle (8) is made up of pairs of reciprocal roots ω_1 and ω_1^{-1}, and so on. Then, because the cycle consists of $\frac{s}{2}$ pairs of reciprocal roots, C_1^2 or r_1^2 is the sum of

s^2 terms, each an n^{th} root of unity. Among these unity occurs s times. Let ω_1 occur h_1 times; and let ω_1^λ the second term in (8), occur h' times. Since ω_1^λ may be made the first term in the cycle (8), it must, under the new arrangement, present itself in the value of r_1^2, precisely where ω_1 previously appeared. That is to say, $h' = h_1$. In like manner each of the terms in (8) occurs exactly h_1 times in the expression for r_1^2. The cycle (9) being that which contains all the primitive n^{th} roots of unity, let us, adhering to the notation of previous sections, suppose that, when ω_1 is changed into ω_1^β, C_1 or r_1 becomes C_2 or r_2, C_2 or r_2 becomes C_3 or r_3, and so on. On the same grounds on which every term in (8) occurs the same number of times in the value of r_1^2, each term in the cycle of terms whose sum is C_2 occurs the same number of times; and so on. Therefore

$$r_1^2 = s + h_1 C_1 + h_2 C_2 + \ldots + h_m C_m.$$

$$r_2^2 = s + h_m C_1 + h_1 C_2 + \ldots + h_{m-1} C_m,$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$r_m^2 = s + h_2 C_1 + h_3 C_2 + \ldots + h_1 C_m.$$

Therefore, keeping in view (11), $\Sigma_1^1 = ms - (h_1 + h_2 + \ldots + h_m)$. But $s^2 - s$ is the number of the terms in the value of r_1^2 which are primitive n^{th} roots of unity. And this must be equal to

$$s\,(h_1 + \ldots + h_m).$$

Therefore

$$h_1 + h_2 + \ldots + h_m = s - 1 \ \therefore\ \Sigma_1^1 = ms + 1 - s = n - s.$$

Again, because r_1 is made up of pairs of reciprocal roots, and because therefore unity does not occur among the s^2 terms of which $r_1 r_2$ is the sum,

$$r_1 r_2 = k_1 C_1 + k_2 C_2 + \ldots + k_m C_m,$$

$$r_2 r_3 = k_m C_1 + k_1 C_2 + \ldots + k_{m-1} C_m,$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$r_m r_1 = k_2 C_1 + k_3 C_2 + \ldots + k_1 C_m;$$

where k_1, k_2, etc., are whole numbers whose sum is s. Therefore $\Sigma_2^1 = -s$. In like manner each of the terms in (33) except the first is equal to $-s$. Therefore (34) becomes

$$\Delta_1^{\frac{1}{m}}\,\Delta_{m-1}^{\frac{1}{m}} = (n - s) - s\,(t_1 + t_1^2 + \text{etc.}) = n.$$

Let us reason now on the assumption that the cycle (8) is not made up of pairs of reciprocal roots. It contains in that case no reciprocal roots. By the same reasoning as above we get $\Sigma_1^1 = -s$. As regards the terms in (33) after the first, one of the terms C_1, C_2, etc., say C_s, must be such that the n^{th} roots of unity of which it is the sum are reciprocals of those of which C_1 is the sum. In passing from C_1 to C_s, we change r_1 into r_s. In fact, C_1 being r_1, C_s is r_s. This being kept in view, we get, by the same reasoning as above, $\Sigma_s^1 = n - s$. But, if any of the expressions C_1, C_2, etc., except C_s be selected, say C_a, none of the roots in (8) are reciprocals of any of those of which C_a is the sum. Therefore $\Sigma_a^1 = -s$. Therefore, from (34)

$$\Delta_1^{\frac{1}{m}} \Delta_{m-1}^{\frac{1}{m}} = -s + (n-s)\, t_1^{s-1}$$

$$-s\left\{(t_1 + t_1^2 + \dots + t_1^{m-1}) - t_1^{s-1}\right\} = n.$$

In like manner every one of the expressions in (34) can be shown to have the value n.

§42. Two numerical illustrations of the law established in the preceding section may be given. The reducing Gaussian equation of the third degree to the equation $x^{19} - 1 = 0$ is $x^3 - x^2 - 6x - 7 = 0$; which gives

$$r_1 = \tfrac{1}{3}(-1 + \Delta_1^{\frac{1}{3}} + \Delta_2^{\frac{1}{3}}),$$
$$2\Delta_1 = 19\,(7 + 3\surd 3),$$
$$2\Delta_2 = 19\,(7 - 3\surd 3),$$
$$\Delta_1^{\frac{1}{3}}\Delta_2^{\frac{1}{3}} = 19.$$

The next example is taken from Lagrange's Theory of Algebraical Equations, Note XIV., §30. The Gaussian of the fifth degree to the equation $x^{11} - 1 = 0$ is $x^5 + x^4 - 4x^3 - 3x^2 + 3x + 1 = 0$; which gives

$$r_1 = \tfrac{1}{5}(-1 + \Delta_1^{\frac{1}{5}} + \Delta_2^{\frac{1}{5}} + \Delta_3^{\frac{1}{5}} + \Delta_4^{\frac{1}{5}});$$
$$4\,\Delta_1 = 11\,(-89 - 25\surd 5 + 5p - 45q),$$
$$4\,\Delta_2 = 11\,(-89 + 25\surd 5 - 45p - 5q),$$
$$4\,\Delta_4 = 11\,(-89 - 25\surd 5 - 5p + 45q),$$
$$4\,\Delta_3 = 11\,(-89 + 25\surd 5 + 45p + 5q),$$
$$p = \surd(-5 - 2\surd 5),$$
$$q - \surd(-5 + 2\surd 5),$$
$$pq = -\surd 5 \;\therefore\; \Delta_1\Delta_4 = 11^5.$$

§43. PROPOSITION XII. To solve the Gaussian.

The path we have been following leads directly, assuming the primitive m^{th} root of unity t_1 to be known, to the solution of the reducing Gaussian equation of the m^{th} degree to the equation $x^n - 1 = 0$. For, as in §41, the roots of the Gaussian are C_1, C_2, etc. Therefore g, the sum of the roots, is -1. Therefore

$$r_1 = \frac{1}{m}\left(-1 + \Delta_1^{\frac{1}{m}} + \Delta_2^{\frac{1}{m}} + \ldots\ldots + \Delta_{m-1}^{\frac{1}{m}}\right). \tag{35}$$

By Prop. VIII., Δ_1, Δ_2, etc., are rational functions of t_1. Therefore

$$\left.\begin{array}{l} \Delta_1 = k_1 + k_2 t_1 + k_3 t_1^2 + \ldots\ldots + k_m t_1^{m-1} \\ \Delta_2 = k_1 + k_2 t_1^2 + k_3 t_1^4 + \ldots\ldots + k_m t_1^{2(m-1)} \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \Delta_{m-1} = k_1 + k_2 t_1^{-1} + k_3 t_1^{-2} + \ldots\ldots + k_m t_1\,; \end{array}\right\} \tag{36}$$

where k_1, k_2, etc., are rational. From the first of equations (26), putting C_1 for r_1, C_2 for r_2, and so on,

$$\Delta_1 = (C_1 + t_1 C_2 + \text{etc.})^m.$$

By actual involution this gives us k_1, k_2, etc., as determinate functions of C_1, C_2, etc., and therefore as known rational quantities. For instance take k_1. Being a determinate function of C_1, C_2, etc., we have

$$k_1 = q_1 + q_2 C_1 + q_3 C_2 + \ldots\ldots + q_m C_{m-1}\,;$$

where q_1, q_2, etc., are known rational quantities. But, by §13, the rational coefficients $q_1 - k_1$, q_2', etc., are all equal to one another. Therefore $k_1 = q_1 - q_2$. In like manner k_2, k_3, etc., are known. Therefore, from (36), Δ_1, Δ_2, etc., are known. Therefore, from (35), r_1 is known.

§44. PROPOSITION XIII. The law established in Prop. X falls under the following more general law. The $m - 1$ expressions in each of the groups

$$\left.\begin{array}{l} \left(\Delta_1^{\frac{1}{m}}\Delta_{m-1}^{\frac{1}{m}},\ \Delta_2^{\frac{1}{m}}\Delta_{m-2}^{\frac{1}{m}},\ \ldots\ldots,\ \Delta_{m-1}^{\frac{1}{m}}\Delta_1^{\frac{1}{m}},\right) \\ \left(\Delta_1^{\frac{2}{m}}\Delta_{m-2}^{\frac{1}{m}},\ \Delta_2^{\frac{2}{m}}\Delta_{m-4}^{\frac{1}{m}},\ \ldots\ldots,\ \Delta_{m-1}^{\frac{2}{m}}\Delta_2^{\frac{1}{m}},\right) \\ \left(\Delta_1^{\frac{3}{m}}\Delta_{m-3}^{\frac{1}{m}},\ \Delta_2^{\frac{3}{m}}\Delta_{m-6}^{\frac{1}{m}},\ \ldots\ldots,\ \Delta_{m-1}^{\frac{3}{m}}\Delta_3^{\frac{1}{m}};\right) \end{array}\right\} \tag{37}$$

and so on, are the roots of a rational equation of the $(m - 1)^{th}$ degree.

The $m-1$ terms in the first of the groups (37) are the $\frac{m-1}{2}$ terms in (32) each taken twice. Therefore, by Prop. X., the law enunciated in the present Proposition is established so far as this groupe is concerned. The general proof is as follows. By (30) in §38, taken in connection with (26), $p_{m-z}\,\Delta_1^{\frac{m-z}{m}} = \Delta_{m-z}^{\frac{1}{m}}$. Therefore $\Delta_1^{\frac{z}{m}}\,\Delta_{m-z}^{\frac{1}{m}} = p_{m-z}\,\Delta_1$. But, by §38, p_{m-z} is a rational function of t_1; and, by Prop. VIII., Δ_1 is a rational function of t_1. Therefore $\Delta_1^{\frac{z}{m}}\,\Delta_{m-z}^{\frac{1}{m}}$ is a rational function of t_1. Also from the manner in which p_{m-z} is formed, when t_1 in $p_{m-2}\,\Delta_1$ is changed sucessively into $t_1\,t_1^2$, ..., t_1^{m-1}, the expression $\Delta_1^{\frac{z}{m}}\,\Delta_{m-z}^{\frac{1}{m}}$ is changed successively into the $m-1$ terms of that one of the groups (37) whose first term is $\Delta_1^{\frac{z}{m}}\,\Delta_{m-z}^{\frac{1}{m}}$. Therefore the terms in that group are the roots of a rational equation.

§45. *Cor.* The law established in the Proposition may be brought under a yet wider generalization. The expression

$$\Delta_1^{\frac{a}{m}}\,\Delta_2^{\frac{b}{m}}\,\Delta_3^{\frac{c}{m}}\,\ldots\,\Delta_{m-1}^{\frac{s}{m}} \tag{38}$$

is the root of a rational equation of the $(m-1)^{\text{th}}$ degree, if

$$a + 2b + 3c + \ldots + (m-1)\,s = Wm,$$

W being a whole number. For, by (30) in connection with (26), $\Delta_2^{\frac{1}{m}} = p_2\,\Delta_1^{\frac{2}{m}}$, $\Delta_3^{\frac{1}{m}} = p_3\,\Delta_3^{\frac{1}{m}}$, and so on. Therefore (38) has the value

$$.(p_2^b\,p_3^c\,\ldots)\,\Delta_1^{\frac{a+2b+3c+\ldots+(m-1)s}{m}}, \text{ or } (p_2^b\,p_3^c\,\ldots)\,\Delta_1^{W}.$$

This is a rational function of t_1, and therefore the root of a rational equation of the $(m-1)^{\text{th}}$ degree.

THE EQUATION $F(x) = 0$ OF THE SECOND CLASS.

§46. We now suppose that the simplified root r_1 of the rational irreducible equation $F(x) = 0$ of the m^{th} degree, m prime, involves, when modified according to §21, a principal surd not a root of unity. It must not be forgotten that, when we thus speak of roots of unity, we mean, according to §1, roots which have prime numbers for the denominators of their indices. In this case conclusions can be established similar to those reached in the case that has been considered. The root r_1 is still of the form (29). The equation $F(x) = 0$ has still an auxiliary of the $(m - 1)^{\text{th}}$ degree, whose roots are the m^{th} powers of the expressions

$$\Delta_1^{\frac{1}{m}},\ a_1 \Delta_1^{\frac{2}{m}},\ b_1 \Delta_1^{\frac{3}{m}},\ \ldots\ldots,\ e_1 \Delta_1^{\frac{m-2}{m}},\ h_1 \Delta_1^{\frac{m-1}{m}}, \tag{39}$$

though the auxiliary here is not necessarily irreducible. Also, substituting the expressions in (39) for $\Delta_1^{\frac{1}{m}}$ $\Delta_2^{\frac{1}{m}}$, etc., in (37), the law of Proposition XIII. still holds, together with corollary in §45.

§47. By Cor. Prop. VI., the denominator of the index of a surd of the highest rank in r_1 is m. Let $\Delta_1^{\frac{1}{m}}$ be such a surd. By §21, the coefficients of the different powers of $\Delta_1^{\frac{1}{m}}$ in r_1 cannot be all zero. We may take the coefficient of the first power to be distinct from zero and to be $\frac{1}{m}$ for, if it were $\frac{k_1}{m}$, we might substitute $s^{\frac{1}{m}}$ for $k_1\Delta_1^{\frac{1}{m}}$, and so eliminate $\Delta_1^{\frac{1}{m}}$ from r_1, introducing in its room the new surd $s^{\frac{1}{m}}$ with $\frac{1}{m}$ for the coefficient of its first power. We may then put

$$r_1 = \frac{1}{m}\left(g + \Delta_1^{\frac{1}{m}} + a_1 \Delta_1^{\frac{3}{m}} + \ldots\ldots + e_1 \Delta_1^{\frac{m-2}{m}} + h_1 \Delta_1^{\frac{m-1}{m}}\right); \tag{40}$$

where g, a_1, etc., are clear of $\Delta_1^{\frac{1}{m}}$. When $\Delta_1^{\frac{1}{m}}$ is changed successively into $\Delta_1^{\frac{1}{m}}$, $t_1^{-1}\Delta_1^{\frac{1}{m}}$, $t_1^{-2}\Delta_1^{\frac{1}{m}}$, etc., let

$$r_1,\ r_2,\ \ldots\ldots\ r_m, \tag{41}$$

be respectively what r_1 becomes, t_1 being a primitive m^{th} root of unity. By Prop. VI., the terms in (41) are the roots of the equation $F(x) = 0$. Taking r_n, any one of the particular cognate forms of R, let $\Delta_n^{\frac{1}{m}}$, a_n, etc., be respectively what $\Delta_1^{\frac{1}{m}}$, a_1, etc., become in passing from r_1 to r_n; and when $\Delta_n^{\frac{1}{m}}$ is changed successively into the different m^{th} roots of the determinate base Δ_n, let r_n become

$$r_n,\ r_n',\ r_n'',\ \ldots\ldots,\ r_n^{(m-1)}. \tag{42}$$

By Prop. II., the terms in (42) are roots of the equation $F(x) = 0$; and, by §23, they are all unequal. Therefore they are identical, in some order, with the terms in (41). Also, the sum of the terms in (41) is g. Therefore g is rational.

§48. Proposition XIV. In r_1, as expressed in (40), $\Delta_1^{\frac{1}{m}}$ is the only principal (see §2) surd.

Suppose, if possible, that there is in r_1 a principal surd $z_1^{\frac{1}{c}}$ distinct from $\Delta_1^{\frac{1}{m}}$. And first, let $z_1^{\frac{1}{c}}$ be not a root of unity. (It will be kept in view that when, in such a case, we speak of roots of unity, the denominators of their indices are understood, according §1, to be prime numbers.) When $z_1^{\frac{1}{c}}$ is changed into $z_2^{\frac{1}{c}}$, one of the other c^{th} roots of z_1, let r_1, a_1, etc., become respectively r_1', a_1', etc. Then

$$mr_1', = g + \Delta_1^{\frac{1}{m}} + a_1'\ \Delta_1^{\frac{2}{m}} + \text{etc} \tag{43}$$

By Prop. II., r_1' is equal to a term in (41), say to r_n. And, by §48, putting t_{n-1} for t_1^{1-n},

$$mr_n = g + t_{n-1}\,\Delta_1^{\frac{1}{m}} + t_{n-1}^2\,a_1\,\Delta_1^{\frac{2}{m}} + \text{etc.} \tag{44}$$

Therefore,

$$\Delta_1^{\frac{1}{m}}\,(1 - t_{n-1}) + \Delta_1^{\frac{2}{m}}\,(a'_1 - a_1\,t_{n-1}^2) + \text{etc.} = 0. \tag{45}$$

This equation involves no surds except those found in the simplified expression r_1, together with the primitive m^{th} root of unity. Therefore the expression on the left of (45) is in a simple state. Therefore, by §8, the coefficients of the different powers of $\Delta_1^{\frac{1}{m}}$ are separately zero. Therefore $t_{n-1} = 1$, $a_1' = a_1$, $b_1' = b_1$, and so on. But, as was shown in Prop. V., $z_1^{\frac{1}{c}}$ being a principal surd not a root of unity in the simplified expression a_1, a_1' cannot be equal to a_1 unless $z_1^{\frac{1}{c}}$ can be eliminated from a_1 without the introduction of any new surd. In like manner b_1' cannot be equal to b_1 unless $z_1^{\frac{1}{c}}$ can be eliminated from b_1. And so on. Therefore, because $a_1' = a_1$, and $b_1' = b_1$, and so on, $z_1^{\frac{1}{c}}$ admits of being eliminated from r_1 without the introduction of any new surd, which, by §21, is impossible. Next, let $z_1^{\frac{1}{c}}$ be a root (see §1) of unity, which may be otherwise written θ_1. Let the different primitive c^{th} roots of unity be θ_1, θ_2, etc.; and, when θ_1 is changed successively into θ_1, θ_2, etc., let r_1 become successively r_1, r_1', etc. Suppose if possible that the $c - 1$ terms r_1, r_1', etc., are all equal. Since $z_1^{\frac{1}{c}}$ is a principal surd in r_1, we may put $r_1 = h\theta_1^{c-1} + k\theta_1^{c-2} + \ldots\ldots + l$; where h, k, etc., are clear of θ_1. Therefore $(c - 1)\, r_1 = cl - (h + k + \text{etc.})$ Thus $z_1^{\frac{1}{c}}$ may be eliminated from r_1 without the introduction of any new surd; which by §21 is impossible. Since then the terms r_1, r_1', etc., are not all equal, let r_1 and r_1' be unequal. Then r_1' is equal to a term in (41) distinct from r_1, say to r_n. Expressing mr_1 and mr_n as in (43) and (44), we deduce (45); which, as above, is impossible.

§49. Proposition XV. Taking r_1, r_n, $\Delta_n^{\frac{1}{m}}$, etc., as in §47, an equation

$$t\,\Delta_n^{\frac{1}{m}} = p\,\Delta_1^{\frac{c}{m}} \tag{46}$$

can be formed; where t is an m^{th} root of unity, and c is a whole number less than m but not zero, and p involves only surds subordinate (see §3) to $\Delta_1^{\frac{1}{m}}$ or $\Delta_n^{\frac{1}{m}}$

By §47, one of the terms in (42) is equal to r_1. For our argument it is immaterial which be selected. Let $r_n = r_1$. Therefore

$$\begin{aligned}(h_n \Delta_n^{\frac{m-1}{m}} + e_n \Delta_n^{\frac{m-2}{m}} + \dots + \Delta_n^{\frac{1}{m}})\\ - (h_1 \Delta_1^{\frac{m-1}{m}} + e_1 \Delta_1^{\frac{m-2}{m}} + \dots + \Delta_1^{\frac{1}{m}}) = 0.\end{aligned} \qquad (47)$$

The coefficients of the different powers of $\Delta_n^{\frac{1}{m}}$ here are not all zero, for the coefficient of the first power is unity. Therefore by §5, an equation $t\Delta_n^{\frac{1}{m}} = l_1$ subsists, t being an m^{th} root of unity, and l_1 involving only surds exclusive of $\Delta_n^{\frac{1}{m}}$ that occur in (47). By Prop. XIV., $\Delta_1^{\frac{1}{m}}$ is a surd of a higher rank (see §3) than any surd in (47) except $\Delta_n^{\frac{1}{m}}$. Therefore we may put

$$l_1 = d + d_1 \Delta_1^{\frac{1}{m}} + d_2 \Delta_1^{\frac{2}{m}} + \dots + d_{m-1} \Delta_1^{\frac{m-1}{m}};$$

where d, d_1, etc., involve only surds lower in rank than $\Delta_1^{\frac{1}{m}}$. Then

$$\begin{aligned}\Delta_n = l_1^m &= (d + d_1 \Delta_1^{\frac{1}{m}} + \text{etc.})^m\\ &= d' + d_1' \Delta_1^{\frac{1}{m}} + d_2' \Delta_1^{\frac{2}{m}} + \text{etc.};\end{aligned}$$

where d', d_1', etc., involve only surds lower in rank than $\Delta_1^{\frac{1}{m}}$. By §8, since $\Delta_1^{\frac{1}{m}}$ is a surd in the simplified expressions r_1, the coefficients $d' - \Delta_n$, d_1', etc., in the equation

$$(d' - \Delta_n) + d_1' \Delta_1^{\frac{1}{m}} + d_2' \Delta_1^{\frac{1}{m}} + \text{etc.} = 0 \qquad (48)$$

are separately zero. Therefore $(d + d_1 \Delta_1^{\frac{1}{m}} + \text{etc.})^m = d'$. And, t_1 being a primitive m^{th} root of unity,

$$(d + d_1 t_1 \Delta_1^{\frac{1}{m}} + \text{etc.})^m = d' + d' t_1 \Delta_1^{\frac{1}{m}} + \text{etc.} = d'.$$

Therefore,

$$(d + d_1 t_1 \Delta_1^{\frac{1}{m}} + \text{etc.}) = t_1^a (d + d_1 \Delta_1^{\frac{1}{m}} + d_2 \Delta_1^{\frac{2}{m}} + \text{etc.}),$$

t_1^a being one of the m^{th} roots of unity. In the same way in which the coefficients of the different powers of $\Delta_1^{\frac{1}{m}}$ in (48) are separately zero, each of the expressions $d\,(1 - t_1^a)$, $d_1\,(t_1 - t_1^a)$, etc., must be zero. But not more than one of the $m - 1$ factors, $t_1 - t_1^a$, $t_1^2 - t_1^a$, etc., can be zero. Therefore not more than one of the $m - 1$ terms d_1, d_2, etc., is distinct from zero. Suppose if possible that all these terms are zero. Then $t\,\Delta_n^{\frac{1}{m}} = d$. Therefore the different powers of $\Delta_n^{\frac{1}{m}}$ can be expressed in terms of the surds involved in d and of the m^{th} root of unity. Substitute for $\Delta_n^{\frac{1}{m}}$, $\Delta_n^{\frac{2}{m}}$ etc., in (47), their values thus obtained. Then (47) becomes

$$Q - (h_1 \Delta_1^{\frac{m-1}{m}} + \ldots . + \Delta_1^{\frac{1}{m}}) = 0; \qquad (49)$$

where Q involves no surds, distinct from the primitive m^{th} root of unity, that are not lower in rank than $\Delta_1^{\frac{1}{m}}$; which, because the coefficient of the first power of $\Delta_1^{\frac{1}{m}}$ in (49) is not zero, is, by §8, impossible. Hence there must be one, while at the same there can be only one of the $m - 1$ terms, d_1, d_2, etc., distinct from zero. Let

d_c be the term that is not zero. Then $t_1^c - t_1^a = 0$. Therefore $1 - t_1^a$ is not zero. Therefore $d = 0$. Therefore, putting p for d_c,

$$t\,\varDelta_n^{\frac{1}{m}} = p\,\varDelta_1^{\frac{c}{m}}.$$

§50. *Cor.* By the proposition, values of the different powers of $\varDelta_n^{\frac{1}{m}}$ can be obtained as follows;

$$t\varDelta_n^{\frac{1}{m}} = p\,\varDelta_1^{\frac{c}{m}},\, t^2\varDelta_n^{\frac{2}{m}} = q\,\varDelta_1^{\frac{s}{m}},\, t^3\varDelta_n^{\frac{3}{m}} = k\,\varDelta_1^{\frac{z}{m}},\text{ etc.}; \tag{50}$$

where p, q, etc., involve only surds that occur in $\varDelta_1$ or $\varDelta_n$; and c, s, z, etc., are whole numbers in the series $1, 2, \ldots, m-1$. No two of the numbers c, s, etc., can be the same; for they are the products, with multiples of the prime number m left out, of the terms in the series $1, 2, \ldots, m-1$, by the whole number c which is less than m. Therefore the series c, s, z, etc., is the series $1, 2, \ldots, m-1$, in a certain order.

§51. Proposition XVI. If r_n be one of the particular cognate forms of R, the expressions

$$t\varDelta_n^{\frac{1}{m}},\, t^2 a_n\varDelta_n^{\frac{2}{m}},\, \ldots,\, t^{m-2} e_n\varDelta_n^{\frac{m-2}{m}},\, t^{m-1} h_n\varDelta_n^{\frac{m-1}{m}}, \tag{51}$$

are severally equal, in some order, to those in (39), t being one of the m^{th} roots of unity.

By §47, one of the terms in (42) is equal to r_1. For our argument it is immaterial which be chosen. Let $r_n = r_1$. By Cor. Prop. XV., the equations (50) subsist. Substitute in (47) the values of the different powers of $\varDelta_n^{\frac{1}{m}}$ so obtained. Then

$$\begin{aligned}&(t^{-1}p\,\varDelta_1^{\frac{c}{m}} + t^{-2}qa_n\varDelta_1^{\frac{s}{m}} + \text{etc.})\\ &-(\varDelta_1^{\frac{1}{m}} + a_1\varDelta_1^{\frac{2}{m}} + \text{etc.}) = 0.\end{aligned} \tag{52}$$

By Cor. Prop. XV., the series $\varDelta_1^{\frac{c}{m}}$, $\varDelta_1^{\frac{s}{m}}$, etc., is identical, in some order, with the series $\varDelta_1^{\frac{1}{m}}$, $\varDelta_1^{\frac{2}{m}}$, etc. Also, by §8, since $\varDelta_1^{\frac{1}{m}}$ is a

surd occurring in the simplified expression r_1, and since besides $\Delta_1^{\frac{1}{m}}$ there are in (52) no surds, distinct from the primitive m^{th} root of unity, that are not lower in rank than $\Delta_1^{\frac{1}{m}}$, if the equation (52) were arranged according to the powers of $\Delta_1^{\frac{1}{m}}$ lower than the m^{th}, the coefficients of the different powers of $\Delta_1^{\frac{1}{m}}$ would be separately zero. Hence $\Delta_1^{\frac{1}{m}}$ is equal to that one of the expressions,

$$t^{-1} p \, \Delta_1^{\frac{c}{m}}, \; t^{-2} q a_n \, \Delta_1^{\frac{s}{m}}, \text{ etc.} \tag{53}$$

in which $\Delta_1^{\frac{1}{m}}$ is a factor. In like manner $a_1 \Delta_1^{\frac{2}{m}}$ is equal to that one of the expressions (53) in which $\Delta_1^{\frac{2}{m}}$ is a factor. And so on. Therefore the terms $\Delta_1^{\frac{1}{m}}$, $a_1 \Delta_1^{\frac{2}{m}}$, etc., forming the series (39), are severally equal, in some order, to the terms in (53), which are those forming the series (51.)

§52. PROPOSITION XVII. The equation $F(x) = 0$ has a rational *auxiliary* (Compare Prop. VII.) equation $\varphi(x) = 0$, whose roots are the m^{th} powers of the terms in (39).

Let the unequal particular cognate forms of the generic expression Δ under which the simplified expression Δ_1 falls be

$$\Delta_1, \; \Delta_2, \; \dots, \; \Delta_c. \tag{54}$$

By Prop. XVI., there is a value t of the m^{th} root of unity for which the expressions

$$t \, \Delta_2^{\frac{1}{m}}, \; t^2 a_2 \Delta_2^{\frac{2}{m}}, \; \dots, \; t^{m-2} e_2 \Delta_2^{\frac{m-2}{m}}, \; t^{m-1} h_2 \Delta_2^{\frac{m-1}{m}} \tag{55}$$

are severally equal, in some order, to those in (39). Therefore Δ_2 is equal to one of the terms

$$\Delta_1, \; a_1^m \Delta_1^2, \dots, e_1^m \Delta_1^{m-2}, \; h_1^m \Delta_1^{m-1}. \tag{56}$$

In like manner each of the terms in (54) is equal to a term in (56). And, because the terms in (54) are unequal, they are severally equal to different terms in (56). By Prop. III., the terms in (54) are the roots of a rational irreducible equation, say $\psi_1(x) = 0$. Rejecting from the series (56) the roots of the equation $\psi_1(x) = 0$, certain of the remaining terms must in the same way be the roots of a rational irreducible equation $\psi_2(x) = 0$. And so on. Ultimately, if $\varphi(x)$ be the continued product of the expressions $\psi_1(x)$, $\psi_2(x)$, etc., the terms in (56) are the roots of the rational equation $\varphi(x) = 0$.

§53. The equations $\psi_1(x) = 0$, $\psi_2(x) = 0$, etc., formed by means of the expressions $\psi_1(x)$, $\psi_2(x)$, etc., may be said to be *sub-auxiliary* to the equation $F(x) = 0$. It will be observed that the subauxiliaries are all irreducible.

§54. PROPOSITION XVIII. In passing from r_1 to r_n, while $\varDelta_1$ becomes $\varDelta_n$, the expressions a_1, b_1, which, by Prop. XIV., involve only surds occurring in $\varDelta_1$, must severally receive determinate values, a_n, b_n, etc. In other words, a_1 being a particular cognate form of A, there cannot, for the same value of $\varDelta_n$, be two particular cognate forms of A, as a_n and a_N, unequal to one another. And so in the case of b_1, e_1, etc.

For, just as each of the terms in (42) is equal to a term in (41), there are primitive m^{th} roots of unity τ and T such that the expressions

$$\tau \varDelta_n^{\frac{1}{m}} + \tau^2 a_n \varDelta_n^{\frac{2}{m}} + \text{etc.},\quad T \varDelta_N^{\frac{1}{m}} + T^2 a_N \varDelta_N^{\frac{1}{m}} + \text{etc.},$$

are equal to one another. Therefore, if $\varDelta_N = \varDelta_n$, in which case, by assigning suitable values to τ and T, $\varDelta_N^{\frac{1}{m}}$ may be taken to be equal to $\varDelta_n^{\frac{1}{m}}$,

$$\varDelta_n^{\frac{1}{m}}(\tau - T) + \varDelta_n^{\frac{2}{m}}(a_n \tau^2 - a_N T^2) + \text{etc.} = 0. \tag{57}$$

Suppose if possible that the coefficients of the different powers of $\varDelta_1^{\frac{1}{m}}$ in (57) are not all zero. Then, by §5, $t\, \varDelta_n^{\frac{1}{m}} = l_1$; t being an m^{th} root of unity; and l_1 involving only surds of lower ranks than $\varDelta_1^{\frac{1}{m}}$. Hence, by Prop. XV. and Cor. Prop. XV., $\varDelta_1^{\frac{1}{m}}$ is a rational function of surds of lower ranks than $\varDelta_1^{\frac{1}{m}}$ and of the

primitive m^{th} root of unity; which, by the definition in §6, is impossible. Since then the coefficients of the different powers of $\Delta_n^{\frac{1}{m}}$ in (57) are separately zero, $\tau = T$, $a_n \tau^2 = a_N T^2$, therefore $a_n = a_N$.

§55. PROPOSITION XIX. Let the terms in (39) be written respectively

$$\Delta_1^{\frac{1}{m}},\ \delta_2^{\frac{1}{m}},\ \delta_3^{\frac{1}{m}},\ \ldots\ldots,\ \delta_{m-1}^{\frac{1}{m}}. \tag{58}$$

The symbols Δ_1, δ_2, δ_3, etc., are employed instead of Δ_1, Δ_2, Δ_3, etc., because this latter notation might suggest, what is not necessarily true, that the terms in (56) are all of them particular cognate forms of the generic expression under which Δ_1 falls. Then (compare Prop. XIII.) the $m - 1$ expressions in each of the groups

$$\left.\begin{array}{l}
(\Delta_1^{\frac{1}{m}}\,\delta_{m-1}^{\frac{1}{m}},\ \delta_2^{\frac{1}{m}}\,\delta_{m-2}^{\frac{1}{m}},\ \delta_3^{\frac{1}{m}}\,\delta_{m-3}^{\frac{1}{m}},\ \ldots\ldots,\ \delta_{m-1}^{\frac{1}{m}}\,\Delta_1^{\frac{1}{m}},) \\
(\Delta_1^{\frac{2}{m}}\,\delta_{m-2}^{\frac{1}{m}},\ \delta_2^{\frac{2}{m}}\,\delta_{m-4}^{\frac{1}{m}},\ \delta_3^{\frac{2}{m}}\,\delta_{m-6}^{\frac{1}{m}},\ \ldots\ldots,\ \delta_{m-1}^{\frac{2}{m}}\,\delta_2^{\frac{1}{m}},) \\
(\Delta_1^{\frac{3}{m}}\,\delta_{m-3},\ \delta_2^{\frac{3}{m}}\,\delta_{m-6}^{\frac{1}{m}},\ \delta_3^{\frac{3}{m}}\,\delta_{m-9}^{\frac{1}{m}},\ \ldots\ldots,\ \delta_{m-1}^{\frac{3}{m}}\,\delta_3^{\frac{1}{m}},)
\end{array}\right\} \tag{59}$$

and so on, are the roots of a rational equation of the $(m - 1)^{th}$ degree. Also (compare Prop. X.) the first $\frac{m-1}{2}$ terms in the first of the groups (59) are the roots of a rational equation of the $\left(\frac{m-1}{2}\right)^{th}$ degree.

In the enunciation of the proposition the remark is made that the series (54) is not necessarily identical with the series

$$\Delta_1,\ \delta_2,\ \delta_3,\ \ldots\ldots,\ \delta_{m-1}.$$

The former consists of the unequal particular cognate forms of Δ; the latter consists of the roots of the auxiliary equation $\varphi\ (x) = 0$. These two series are identical only when the auxiliary is irreducible. To prove the first part of the proposition, take the terms forming the second of the groups (59). Because $\delta_{m-2}^{\frac{1}{m}}$ represents $e_1\,\Delta_1^{\frac{m-2}{m}}$,

$$e_1 \Delta_1 = \Delta_1^{\frac{2}{m}} \delta_{m-}^{\frac{1}{m}} .$$

Let E be the generic symbol under which the simplified expression e_1 falls. By Prop. XVIII., when Δ_1 is changed successively into the c terms in (54), e_1 receives successively the determinate values $e_1, e_2, \ldots, e_c$; and therefore $e_1 \Delta_1$ receives successively the determinate values

$$e_1 \Delta_1 , \; e_2 \Delta_2 , \; \ldots , \; e_c \Delta_c . \tag{60}$$

There is therefore no particular cognate form of $E\Delta$ that is not equal to a term in (60). By Prop. XVI. there is a value of the m^{th} root of unity t for which the terms in (55) are severally equal, in some order, to those in (39). Let the term in (39) to which $t\,\Delta_2^{\frac{1}{m}}$ is equal be $q_1 \Delta_1^{\frac{n}{m}}$ Then, applying the principle of Cor. Prop. XV., as in Prop. XVI., it follows that the term in (39) to which $t^{m-2} e_2 \Delta_2^{\frac{m-2}{m}}$ in (55) is equal is $k_1 \Delta_1^{\frac{M-2n}{m}}$, M being a multiple of m, and $M - 2n$ being less than m. Therefore $e_2 \Delta_2$ is equal to $q_1^2 k_1 \Delta_1^{\frac{M}{m}}$, which is the product of two of the terms in (39) occuring respectively at equal distances from opposite extremities of the series. In other words, $e_2 \Delta_2$ is equal to an expression $\delta_m^{\frac{2}{m}} \delta_{m-2n}^{\frac{1}{m}}$ in the second of the groups (59). In like manner every term in (60) is equal to an expression in the second of the groups (59). Let the unequal terms in (60) be

$$e_1 \Delta_1 , \text{ etc.} \tag{61}$$

Then, by Prop. III., the terms in (61) are the roots of a rational irreducible equation, say $f_1(x) = 0$. Rejecting these, which are distinct terms in the second of the groups (59), it can in like manner be shown that certain other terms in that group are the roots of a rational irreducible equation, say $f_2(x) = 0$. And so on. Ultimately, if $f(x)$ be the continued product of the expressions $f_1(x)$, $f_2(x)$, etc., the terms forming the second of the groups (59) are the roots of a rational equation of the $(m-1)^{\text{th}}$ degree. The proof applies substantially to each of the other groups. To prove the second part, it is only necessary to observe that, in the first of the groups (59), the last term is identical with the first, the last but one with the second, and so on.

§56. *Cor.* 1. The reasoning in the proposition proceeds on the assumption that the prime number m is odd. Should m be even, the series Δ_1, δ_1, etc., is reduced to its first term. The law may be considered even then to hold in the following form. The product $\Delta_1^{\frac{1}{m}}\ \Delta_1^{\frac{1}{m}}$ is the root of a rational equation of the $(m - 1)^{\text{th}}$ degree, or is rational. For this product is Δ_1, which, by Prop. XVII., is the root of an equation of the $(m - 1)^{\text{th}}$ degree.

§56. *Cor.* 2. I merely notice, without farther proof, that the generalization in §45 in the case when the equation $F(x) = 0$ is of the first (see §30) class holds in the present case likewise.

Analysis of Solvable Equations of the Fifth Degree

§58. Let the solvable irreducible equation of the m^{th} degree, which we have been considering, be of the fifth degree. Then, by Prop. IX. and §47, whether the equation belongs to the first or to the second of the two classes that have been distinguished, assuming the sum of the roots g to be zero,

$$r_1 = \tfrac{1}{5}\left(\Delta_1^{\frac{1}{5}} + a_1\,\Delta_1^{\frac{2}{5}} + e_1\,\Delta_1^{\frac{3}{5}} + h_1\,\Delta_1^{\frac{4}{5}}\right), \tag{62}$$

though, when the equation is of the first class, the root, as thus presented, is not in a simple state.

§59. Proposition XX. If the auxiliary biquadratic has a rational root Δ_1 not zero, all the roots of the auxiliary biquadratic are rational.

Because Δ_1 is rational, the auxiliary biquadratic $\varphi(x) = 0$ is not irreducible. Therefore, by Prop. VII., the equation $F(x) = 0$ is of the second (see §30) class. Therefore, by Prop. XIV., $\Delta_1^{\frac{1}{5}}$ is the only principal surd in r_1. Consequently, because Δ_1 is rational, a_1, e_1 and h_1 are rational. Therefore Δ_1, $a_1^5\,\Delta_1^2$, $e_1^5\,\Delta_1^3$, $h_1^5\,\Delta_1^4$, which are the roots of the auxiliary biquadratic, are rational.

§60. Proposition XXI. If the auxiliary biquadratic has a quadratic sub-auxiliary $\psi_1(x) = 0$ with the roots Δ_1 and Δ_2, then $\Delta_2 = h_1^5\,\Delta_1^4$, and $\Delta_1 = h_2^5\,\Delta_2^4$; and $h_1\,\Delta_1$ is rational.

As in §52, t being a certain fifth root of unity, each term in (55) is equal to a term in (39). The first term in (55) cannot be equal to the first in (39), for this would make $\Delta_2 = \Delta_1$. Suppose if possible that the first in (55) is equal to the second in (39). Then, by equations (50), applied as in Prop. XVI.,

$$\left.\begin{aligned} t\,\Delta_2^{\frac{1}{5}} &= a_1\,\Delta_1^{\frac{2}{5}}, \quad t^2\,a_2\,\Delta_2^{\frac{2}{5}} = h_1\,\Delta_1^{\frac{4}{5}}, \\ t^3\,e_2\,\Delta_2^{\frac{3}{5}} &= \Delta_1^{\frac{1}{5}}, \quad t^4\,h_2\,\Delta_2^{\frac{4}{5}} = e_1\,\Delta_1^{\frac{3}{5}}, \\ \text{therefore } \Delta_2 &= a_1^5\,\Delta_1^2, \quad a_2^5\,\Delta_2^2 = h_1^5\,\Delta_1^4, \\ e_2^5\,\Delta_2^3 &= \Delta_1, \quad h_2^5\,\Delta_2^4 = e_1^5\,\Delta_1^3. \end{aligned}\right\} \tag{63}$$

Now $a_1^5\,\Delta_1^2$, being equal to Δ_2, is a root of the equation $\psi_1(x) = 0$. And $a_1^5\,\Delta_1^2$, involving only surds that occur in r_1, is in a simple state. Therefore, by Prop. III., $a_2^5\,\Delta_2^2$ is a root of the equation $\psi_1(x) = 0$. Therefore $h_1^5\,\Delta_1^4$, and therefore also $h_2^5\,\Delta_2^4$ or $e_1^5\,\Delta_1^3$, are roots of that equation. Hence all the terms

$$\Delta_1, \; a_1^5\,\Delta_1^2, \; e_1^5\,\Delta_1^3, \; h_1^5\,\Delta_1^4, \tag{64}$$

are roots of the equation $\psi_1(x) = 0$. But a_1, e_1, h_1, are all distinct from zero; for, by (63), if one of them was zero, all would be zero, and therefore $\Delta_1^{\frac{1}{5}}$ would be zero; which by §6, is impossible. From this it follows that no two terms in (64) are equal to one another; for taking $a_1^5\,\Delta_1^2$ and $e_1^5\,\Delta_1^3$, if these were equal, we should have $e_1\,t'\,\Delta_1^{\frac{1}{5}} = a_1$, t' being a fifth root of unity; which; which by §8, is impossible. This gives the equation $\psi_1(x) = 0$ four unequal roots; which, beeause it is of the second degree, is impossible. Therefore the first term in (55) is not equal to the second in (39). In the same way it can be shown that it is not equal to the third. Therefore it must be equal to the fourth. In like manner the first in (39) is equal to the fourth in (55). Because then $t\,\Delta_2^{\frac{1}{5}} = h_1\,\Delta_1^{\frac{4}{5}}$, and $\Delta_1^{\frac{1}{5}} = t^4\,h_2\,\Delta_2^{\frac{4}{5}}$, $h_2\,\Delta_2 = h_1\,\Delta_1$. But, just as it was proved in §56 that, the roots of the sub-auxiliary $\psi_1(x) = 0$ being the c terms Δ_1, Δ_2, etc., there is no particular cognate form of $E\Delta$ that is not a term in the series $e_1\,\Delta_1$, $e_2\,\Delta_2$, ..., $e_c\,\Delta_c$, it follows that, if h_1 be a particular cognate form of H, there is no particular cognate form of $H\Delta$ that is not equal to one of the terms $h_1\,\Delta_1$ and $h_2\,\Delta_2$. Hence, since $h_1\,\Delta_1 = h_2\,\Delta_2$, $H\Delta$ has no particular cognate form different in value from $h_1\,\Delta_1$. Therefore, by Prop. III., $h_1\,\Delta_1$ is rational.

§61. Proposition XXII. The auxiliary biquadratic $\varphi(x) = 0$ either has all its roots rational, or has a sub-auxiliary (see §53) of the second degree, or is irreducible.

It will be kept in view that the sub-auxiliaries are, by the manner of their formation, irreducible. First, let the series (54), containing the roots of the sub-auxiliary $\psi_1(x) = 0$ consist of a single term Δ_1. Then, by Prop. III., Δ_1 is rational. Therefore, by Prop. XX., all the roots of the auxiliary are rational. Next, let the series (54) consist of the two terms Δ_1 and Δ_2. By this very hypothesis, the auxiliary biquadratic has a quadratic sub-auxiliary. Lastly, let the series (54) contain more than two terms. Then it has the three terms Δ_1, Δ_2, Δ_3. We have shown that these must be severally equal to terms in (64). Neither Δ_2 nor Δ_3 is equal to Δ_1. They cannot both be equal to $h_1^5 \Delta_1^4$. Therefore one of them is equal to one of the terms $a_1^5 \Delta_1^2$, $e_1^5 \Delta_1^3$. But in §60 it appeared that, if Δ_2 be equal either to $a_1^5 \Delta_1^2$ or to $e_1^5 \Delta_1^3$, all the terms in (64) are roots of the irreducible equation of which Δ_1 is a root. The same thing holds regarding Δ_3. Therefore, when the series (54) contains more than two terms, the irreducible equation which has Δ_1 for one of its roots has the four unequal terms in (64) for roots; that is to say, the auxiliary biquadratic is irreducible.

§62. Let $5u_1 = \Delta_1^{\frac{1}{5}}$, $5u_2 = a_1 \Delta_1^{\frac{2}{5}}$, $5u_3 = e_1 \Delta_1^{\frac{3}{5}}$, $5u_4 = h_1 \Delta_1^{\frac{4}{5}}$; and, n being any whole number, let S_n denote the sum of the n^{th} powers of the roots of the equation $F(x) = 0$. Then

$$S_1 = 0;\ S_2 = 10(u_1 u_4 + u_2 u_3);\ S_3 = 15\left\{ \Sigma (u_1 u_2^2) \right\};$$

$$S_4 = 20\left\{ \Sigma (u_1^3 u_2) \right\} + 30(u_1^2 u_4^2 + u_2^2 u_3^2) + 120\, u_1 u_2 u_3 u_4;$$

$$S_5 = 5\left\{ \Sigma (u_1^5) \right\} + 100\left\{ \Sigma (u_1^3 u_3 u_4) \right\} + 150\left\{ \Sigma (u_1 u_3^2 u_4^2) \right\};$$

where such an expression as $\Sigma(u_1 u_2^2)$ means the sum of all such terms as $u_1 u_2^2$; it being understood that, as any one term in the circle u_1, u_2, u_4, u_3, passes into the next, that next passes into its next, u_3 passing into u_1.

The Roots of the Auxiliary Biquadratic all Rational.

§63. Any rational values that may be assigned to Δ_1, a_1, e_1, and h_1 in r_1, taken as in (62), make r_1 the root of a rational equation of the fifth degree, for they render the values of S_1, S_2, etc., in §62, rational. In fact, $S_1 = 0$, $25\, S_2 = 10\, \Delta_1 (h_1 + a_1 e_1)$, and so on.

THE AUXILIARY BIQUADRATIC WITH A QUADRATIC SUB-AUXILIARY.

§64. PROPOSITION XXIII. In order that r_1, taken as in (62), may be the root of an irreducible equation $F(x) = 0$ of the fifth degree, whose auxiliary biquadratic has a quadratic sub-auxiliary, it must be of the form

$$r_1 = \tfrac{1}{5} \left\{ \left(\Delta_1^{\frac{1}{5}} + \Delta_2^{\frac{1}{5}}\right) + \left(a_1 \Delta_1^{\frac{2}{5}} + a_2 \Delta_2^{\frac{2}{5}}\right) \right\}; \qquad (65)$$

where Δ_1 and Δ_2 are the roots of the irreducible equation $\psi_1(x) = x^2 - 2px + q^5 = 0$; and $a_1 = b + d \surd (p^2 - q^5)$, $a_2 = b - d \surd (p^2 - q^5)$; p, b and d being rational; and the roots $\Delta_1^{\frac{1}{5}}$ and $\Delta_2^{\frac{1}{5}}$ being so related that $\Delta_1^{\frac{1}{5}} \Delta_2^{\frac{1}{5}} = q$.

By Prop. VII., when a quintic equation is of the first (see §30) class, the auxiliary biquadratic is irreducible. Hence, in the case we are considering, the quintic is of the second class. The quadratic sub-auxiliary may be assumed to be $\psi_1(x) = x^2 - 2px + k = 0$, p and k being rational. By Prop. XXI., the roots of the equation $\psi_1(x) = 0$ are Δ_1 and $h_1^5 \Delta_1^4$. Therefore $k = (h_1 \Delta_1)^5$; or, putting q for $h_1 \Delta_1$, $k = q^5$. By the same proposition, $h_1 \Delta_1$ is rational. Therefore q is rational. Hence $\psi_1(x)$ has the form specified in the enunciation of the proposition. Next, by Proposition XVI., there is a fifth root of unity t such that $t \Delta_2^{\frac{1}{5}} = h_1 \Delta_1^{\frac{4}{5}}$. If we take t to be unity, which we may do by a suitable interpretation of the symbol $\Delta_2^{\frac{1}{5}}$, $\Delta_2^{\frac{1}{5}} = h_1 \Delta_1^{\frac{4}{5}}$. This implies that $e_1 \Delta_1^{\frac{3}{5}} = a_2 \Delta_2^{\frac{2}{5}}$, a_2 being what a_1 becomes in passing from Δ_1 to Δ_2. Substituting these values of $e_1 \Delta_1^{\frac{3}{5}}$ and $h_1 \Delta_1^{\frac{4}{5}}$ in (62), we obtain the form of r_1 in (65), while at the same time $\Delta_1^{\frac{1}{5}} \Delta_2^{\frac{1}{5}} = h_1 \Delta_1 = q$. The forms of a_1 and a_2 have to be more accurately determined. By Prop. XIV., $\Delta_1^{\frac{1}{5}}$ is the only principal surd that r_1, as presented in (62), contains. Therefore a_1 involves no surd that does not occur in Δ_1; that is to say, $\surd (p^2 - q^5)$ is the only surd in a_1. Hence we may put $a_1 = b + d \surd (p^2 - q^5)$; b and d being rational. But a_2 is what a_1 becomes in passing from Δ_1 to Δ_2. And Δ_2 differs from Δ_1 only in the sign of the root $\surd (p^2 - q^5)$. Therefore

$$a_2 = b - d \surd (p^2 - q^5).$$

§65. Any rational values that may be assigned to b, d, p and q in r_1, taken as in (65), make r_1 the root of a rational equation of the

fifth degree; for they render the values of S_1, S_2, etc., in §62, rational. In fact, $S_1 = 0$, $25\,S_2 = 10\{q + q^2 b^2 - q^2 d^2 (p^2 - q^5)\}$, and so on.

The Auxiliary Biqadratic Irreducible.

§66. When the auxiliary biquadratic is irreducible, the unequal particular cognate forms of Δ are, by Prop. III., four in number, Δ_1, Δ_2, Δ_3, Δ_4. As explained in §55, because the equation $\varphi(x) = 0$ is irreducible, these terms are severaly identical with Δ_1, δ_2, δ_3, δ_4. Hence, putting $m = 5$, the first two terms in the first of the groups (59) may be written in the notation of (37),

$$\Delta_1^{\frac{1}{5}}\,\Delta_4^{\frac{1}{5}},\ \Delta_2^{\frac{1}{5}}\,\Delta_3^{\frac{1}{5}}\,; \tag{66}$$

and the second and third groups may be written

$$\left.\begin{array}{l} (\Delta_1^{\frac{2}{5}}\,\Delta_3^{\frac{1}{5}},\ \Delta_2^{\frac{2}{5}}\,\Delta_1^{\frac{1}{5}},\ \Delta_3^{\frac{2}{5}}\,\Delta_4^{\frac{1}{5}},\ \Delta_4^{\frac{2}{5}}\,\Delta_2^{\frac{1}{5}}) \\ (\Delta_1^{\frac{3}{5}}\,\Delta_2^{\frac{1}{5}},\ \Delta_2^{\frac{3}{5}}\,\Delta_4^{\frac{1}{5}},\ \Delta_3^{\frac{3}{5}}\,\Delta_1^{\frac{1}{5}},\ \Delta_4^{\frac{3}{5}}\,\Delta_3^{\frac{1}{5}}). \end{array}\right\} \tag{67}$$

§67. Proposition XXIV. The roots of the auxiliary biquadratic equation $\varphi(x) = 0$ are of the forms

$$\left.\begin{array}{l} \Delta_1 = m + n\sqrt{z} + \sqrt{s},\ \Delta_2 = m - n\sqrt{z} + \sqrt{s_1}, \\ \Delta_4 = m + n\sqrt{z} - \sqrt{s},\ \Delta_3 = m - n\sqrt{z} - \sqrt{s_1}\,; \end{array}\right\} \tag{68}$$

where $s = p + q\sqrt{z}$, and $s_1 = p - q\sqrt{z}$; m, n, z, p and q being rational; and the surd $\sqrt{s}$ being irreducible.

By Propositions XIII. and XIX., the terms in (66) are the roots of a quadratic. Therefore $\Delta_1\,\Delta_4$ and $\Delta_2\,\Delta_3$ are the roots of a quadratic. Suppose if possible that $\Delta_1\,\Delta_3$ is the root of a quadratic. By Propositions IX. and XIX., $\Delta_3^{\frac{1}{5}} = e_1\,\Delta_1^{\frac{3}{5}}$. Therefore $e_1^5\,\Delta_1^4$ is the root of a quadratic. From this it follows (Prop. III.) that there are not more than two unequal terms in the series,

$$e_1^5\,\Delta_1^4,\ e_2^5\,\Delta_2^4,\ e_3^5\,\Delta_3^4,\ e_4^5\,\Delta_4^4. \tag{69}$$

But suppose if possible that $e_1^5\,\Delta_1^4 = e_2^5\,\Delta_2^4$. Then, t being one of the fifth roots of unity, $te_1\,\Delta_1^{\frac{4}{5}} = e_2\,\Delta_2^{\frac{4}{5}}$ But, by Propositions IX. and XIX., $\Delta_2^{\frac{1}{5}} = h_1\,\Delta_1^{\frac{4}{5}}$. Therefore, $te_1\,\Delta_1^{\frac{4}{5}} = e_2\,h_1^4\,\Delta_1^3\,\Delta_1^{\frac{1}{5}}$. There-

fore, by §8, $e_1 = 0$. Therefore one of the roots of the auxiliary biquadratic is zero; which because the auxiliary biquadratic is assumed to be irreducible, is impossible. Therefore $e_1^5 \Delta_1^4$ and $e_2^5 \Delta_2^4$ are unequal. In the same way all the terms in (69) can be shown to be unequal; which, because it has been proved that there are not more than two unequal terms in (69), is impossible. Therefore $\Delta_1 \Delta_3$ is not the root of a quadratic equation. Therefore the product of two of the roots, Δ_1 and Δ_4, of the auxiliary biquadratic is the root of a quadratic equation, while the product of a different pair, Δ_1 and Δ_3, is not the root of a quadratic. But the only forms which the roots of an irreducible biquadratic can assume consistently with these conditions are those given in (68).

§68. PROPOSITION XXV. The surd $\sqrt{s_1}$ can have its value expressed in terms of $\sqrt{s}$ and $\sqrt{z}$.

By Propositions XIII. and XIX, the terms of the first of the groups (67) are the roots of a biquadratic equation. Therefore their fifth powers

$$\Delta_1^2 \Delta_3 , \; \Delta_2^2 \Delta_1 , \; \Delta_3^2 \Delta_4 , \; \Delta_4^2 \Delta_2 , \tag{70}$$

are the roots of a biquadratic. From the values of Δ_1, Δ_2, Δ_3 and Δ_4 in (68), the values of the terms in (70) may be expressed as follows:

$$\left.\begin{aligned}
\Delta_1^2 \Delta_3 &= F + F_1 \sqrt{z} + (F_2 + F_3 \sqrt{z}) \sqrt{s} \\
&\quad + (F_4 + F_5 \sqrt{z}) \sqrt{s_1} + (F_6 + F_7 \sqrt{z}) \sqrt{s} \sqrt{s_1} , \\
\Delta_2^2 \Delta_1 &= F - F_1 \sqrt{z} + (F_2 - F_3 \sqrt{z}) \sqrt{s_1} \\
&\quad - (F_4 - F_5 \sqrt{z}) \sqrt{s} - (F_6 - F_7 \sqrt{z}) \sqrt{s} \sqrt{s_1} , \\
\Delta_4^2 \Delta_2 &= F - F_1 \sqrt{z} - (F_2 - F_3 \sqrt{z}) \sqrt{s_1} \\
&\quad + (F_4 - F_5 \sqrt{z}) \sqrt{s} - (F_6 - F_7 \sqrt{z}) \sqrt{s} \sqrt{s_1} , \\
\Delta_3^2 \Delta_4 &= F + F_1 \sqrt{z} - (F_2 + F_3 \sqrt{z}) \sqrt{s} \\
&\quad - (F_4 + F_5 \sqrt{z}) \sqrt{s_1} + (F_6 + F_7 \sqrt{z}) \sqrt{s} \sqrt{s_1} ,
\end{aligned}\right\} \tag{71}$$

where F, F_1, etc., are rational. Let $\Sigma(\Delta_1^2 \Delta_3)$ be the sum of the four expressions in (70). Then, because these expressions are the roots of a biquadratic, $\Sigma(\Delta_1^2 \Delta_3)$ or $4F + 4F_7 \sqrt{s} \sqrt{s_1}$, must be rational. Suppose if possible that $\sqrt{s_1}$ cannot have its value expressed in terms of $\sqrt{s}$ and $\sqrt{z}$. Then, because $\sqrt{s} \sqrt{s_1}$ is not rational, $F_7 = 0$. By (68), this implies that $n = 0$. Let

$$\begin{aligned}
(\Delta_1^2 \Delta_3)^2 &= L + L_1 \sqrt{z} + (L_2 + L_3 \sqrt{z}) \sqrt{s} \\
&\quad + (L_4 + L_5 \sqrt{z}) \sqrt{s_1} + (L_6 + L_7 \sqrt{z}) \sqrt{s} \sqrt{s_1} ,
\end{aligned}$$

where L, L_1, etc., are rational. Then, as above, $L_7 = 0$. Keeping in view that $n = 0$, this means that $m^2 q = 0$. But q is not zero, for this would make $\surd s = \surd s_1$; which, because we are reasoning on the hypothesis that $\surd s_1$ cannot have its value expressed in terms of $\surd s$ and $\surd z$, is impossible. Therefore m is zero. And it was shown that n is zero. Therefore $\Delta_1 = \surd s$, and $\Delta_3 = - \surd s$. Therefore $\Delta_1 \Delta_3 = - \surd (p^2 - q^2 z)$; which, because it has been proved that $\Delta_1 \Delta_3$ is not the root of a quadratic equation, is impossible. Hence $\surd s_1$ cannot but be a rational function of $\surd s$ and $\surd z$.

§69. Proposition XXVI. The form of s is

$$h(1 + e^2) + h\surd(1 + e^2), \tag{72}$$

h and e being rational, and $1 + e^2$ being the value of z.

By Prop. XXV., $\surd s_1 = v + c\surd s$, v and c being rational functions of $\surd z$. Therefore $s_1 = v^2 + c^2 s + 2vc\surd s$. By Prop. XXIV., $\surd s$ is irreducible. Therefore $vc = 0$. But c is not zero, for this would make $\surd s_1 = v$, and thus $\surd s_1$ would be the root of a quadratic equation. Therefore $v = 0$, and $\surd s_1 = c\surd s = (c_1 + c_2 \surd z)\surd s$, c_1 and c_2 being rational. Therefore

$$\begin{aligned}\surd(ss_1) = \surd(p^2 - q^2 z) &= (c_1 + c_2\surd z)(p + q\surd z) \\ &= (c_1 p + c_2 q z) + \surd z\,(c_1 q + c_2 p) = P + Q\surd z.\end{aligned}$$

Here, since $p^2 - q^2 z$ is rational, either $P = 0$ or $Q = 0$. As the latter of these alternatives would make $\surd(p^2 - q^2 z)$ rational, and therefore would make $\surd(p + q\surd z)$ or $\surd s$ reducible, it is inadmissible. Therefore $c_1 p + c_2 qz = 0$, and

$$\surd(p^2 - q^2 z) = (c_1 q + c_2 p)\surd z.$$

Now qz is not not zero, for this would make $\surd(ss_1) = \pm p$; which, because $\surd s$ is irreducible, is impossible. Therefore $c_2 = 0$. But, by hypothesis, $c_1 = 0$; therefore $\surd s_1$, which is equal to $(c_1 + c_2\surd z)\surd s$, is zero; which is impossible. Hence c_1 cannot be zero. We may therefore put $ce = 1$, and $h(1 + e^2) = p$. Then $s = p + q\surd z = h(1 + e^2) + h\surd(1 + e^2)$. Having obtained this form, we may consider z to be identical with $1 + e^2$, q with h, and p with $h(1 + e^2)$.

§70. The reasoning in the preceding section holds good whether the equation $F(x) = 0$ be of the first (see §30) or of the second class. If we had had to deal simply with equations of the first class, the proof given would have been unnecessary, so far as the form of z is concerned; because, in that case, by Prop. VIII., Δ_1 is a rational function of the primitive fifth root of unity.

§71. PROPOSITION XXVII. Under the conditions that have been established, the root r_1 takes the form given without deduction in *Crelle* (Vol. V., p. 336) from the papers of Abel.

For, by *Cor.* Prop. XIII. (compare also *Cor.* 2, Prop. XIX.,) the expressions

$$\Delta_1^{\frac{1}{5}}\ \Delta_3^{\frac{2}{5}}\ \Delta_4^{\frac{4}{5}}\ \Delta_2^{\frac{3}{5}},\quad \Delta_2^{\frac{1}{5}}\ \Delta_1^{\frac{2}{5}}\ \Delta_3^{\frac{4}{5}}\ \Delta_4^{\frac{3}{5}},$$

$$\Delta_3^{\frac{1}{5}}\ \Delta_4^{\frac{2}{5}}\ \Delta_2^{\frac{4}{5}}\ \Delta_1^{\frac{3}{5}},\quad \Delta_4^{\frac{1}{5}}\ \Delta_2^{\frac{2}{5}}\ \Delta_1^{\frac{4}{5}}\ \Delta_3^{\frac{3}{5}}, \tag{73}$$

are the roots of a biquadratic equation. In the corollaries referred to, it is merely stated that each of the expressions in (73) is the root of a biquadratic; but the principles of the propositions to which the corollaries are attached show that the four expressions must be the roots of the same biquadratic. Let the terms in (73) be denoted respectively by

$$5A_1^{-1},\qquad 5A_2^{-1},\qquad 5A_3^{-1},\qquad 5A_4^{-1}.$$

Then $\Delta_1^{\frac{1}{5}}\ \Delta_3^{\frac{2}{5}}\ \Delta_4^{\frac{4}{5}}\ \Delta_2^{\frac{3}{5}} = \Delta_4^{\frac{1}{5}}\ (\Delta_1^{\frac{1}{5}}\ \Delta_3^{\frac{2}{5}}\ \Delta_4^{\frac{3}{5}}\ \Delta_2^{\frac{3}{5}})$ is an identity. Therefore

$$\tfrac{1}{5}\ \Delta_4^{\frac{1}{5}} = A_1\ (\Delta_1^{\frac{1}{5}}\ \Delta_3^{\frac{2}{5}}\ \Delta_4^{\frac{4}{5}}\ \Delta_2^{\frac{3}{5}}).\quad \text{Similarly,}$$

$$\tfrac{1}{5}\ \Delta_3^{\frac{1}{5}} = A_3\ (\Delta_3^{\frac{1}{5}}\ \Delta_4^{\frac{2}{5}}\ \Delta_2^{\frac{4}{5}}\ \Delta_1^{\frac{3}{5}})$$

$$\tfrac{1}{5}\ \Delta_2^{\frac{1}{5}} = A_2\ (\Delta_2^{\frac{1}{5}}\ \Delta_1^{\frac{2}{5}}\ \Delta_3^{\frac{4}{5}}\ \Delta_4^{\frac{3}{5}}),\ \text{and}$$

$$\tfrac{1}{5}\ \Delta_1^{\frac{1}{5}} = A_4\ (\Delta_4^{\frac{1}{5}}\ \Delta_2^{\frac{2}{5}}\ \Delta_1^{\frac{4}{5}}\ \Delta_3^{\frac{3}{5}}).$$

Substituting these values in (62), we get

$$r_1 = A_1\,(\Delta_1^{\frac{1}{5}}\ \Delta_3^{\frac{2}{5}}\ \Delta_4^{\frac{4}{5}}\ \Delta_2^{\frac{3}{5}}) + A_2\,(\Delta_2^{\frac{1}{5}}\ \Delta_1^{\frac{2}{5}}\ \Delta_3^{\frac{4}{5}}\ \Delta_4^{\frac{3}{5}})$$

$$+ A_3\,(\Delta_3^{\frac{1}{5}}\ \Delta_4^{\frac{2}{5}}\ \Delta_2^{\frac{4}{5}}\ \Delta_1^{\frac{3}{5}}) + A_4\,(\Delta_4^{\frac{1}{5}}\ \Delta_2^{\frac{2}{5}}\ \Delta_1^{\frac{4}{5}}\ \Delta_3^{\frac{3}{5}}). \tag{74}$$

This, with immaterial differences in the subscripts, is Abel's expression; only we need to determine A_1, A_2, A_3 and A_4 more exactly. These terms are the reciprocals of the terms in (73) severally divided by 5. Therefore they are the roots of a biquadratic. Also, no surds can appear in A_1 except those that are present in Δ_1, Δ_2, Δ_3 and Δ_4. That is to say, A_1 is a rational function of $\surd s$, $\surd s_1$ and $\surd z$. But it was shown that $\surd s_1 \surd s = he \surd z$. Therefore A_1 is a rational function of $\surd s$ and $\surd z$. We may therefore put

$$A_1 = K + K'\ \Delta_1 + K''\ \Delta_4 + K'''\ \Delta_1\ \Delta_4,$$

K, K', K'' and K''' being rational. But the terms Δ_1, Δ_2, Δ_4, Δ_3 circulate with Δ_1, Δ_2, Δ_4, Δ_3. Therefore

$$\begin{aligned} A_2 &= K + K'\,\Delta_2 + K''\,\Delta_3 + K'''\,\Delta_2\,\Delta_3\,, \\ A_4 &= K + K'\,\Delta_4 + K''\,\Delta_1 + K'''\,\Delta_1\,\Delta_4\,, \\ A_3 &= K + K'\,\Delta_3 + K''\,\Delta_2 + K'''\,\Delta_2\,\Delta_3\,, \end{aligned}$$

These are Abel's values.

§72. Keeping in view the values of Δ_1, Δ_2, etc., in (67), and also that $z = 1 + e^2$, and $s = hz + h\sqrt{z}$, any rational values that may be assigned to m, n, e, h, K, K', K'' and K''' make r_1, as presented in (74), the root of an equation of the fifth degree. For, any rational values of m, n, etc., make the values of S_1, S_2, etc., in §62, rational.

§73. It may be noted that, not only is the expression for r_1 in (74) the root of a quintic equation whose auxiliary biquadratic is irreducible, but on the understanding that the surds $\sqrt{s}$ and $\sqrt{z}$ in Δ_1 may be reducible, the expression for r_1 in (74) contains the roots both of all equations of the fifth degree whose auxiliary biquadratics have their roots rational, and of all that have quadratic sub-auxiliaries. It is unecessary to offer proof of this.

§74. The equation $x^5 - 10x^3 + 5x^2 + 10x + 1 = 0$ is an example of a solvable quintic with its auxiliary biquadratic irreducible. One of its roots is

$$\omega^{\frac{1}{5}} + \omega\omega^{\frac{2}{5}} + \omega^3\omega^{\frac{3}{5}} + \omega^4\omega^{\frac{4}{5}},$$

ω being a primitive fifth root of unity. It is obvious that this root satisfies all the conditions that have been pointed out in the preceding analysis as necessary. A root of an equation of the seventh degree of the same character is

$$\omega^{\frac{1}{7}} + \omega^4\omega^{\frac{2}{7}} + \omega^4\omega^{\frac{3}{7}} + \omega^3\omega^{\frac{4}{7}} + \omega^3\omega^{\frac{5}{7}} + \omega^6\omega^{\frac{6}{7}},$$

ω being a primitive seventh root of unity. The general form under which these instances fall can readily be found. Take the cycle that contains all the primitive $(m^2)^{\text{th}}$ roots of unity,

$$\theta,\ \theta^{\beta},\ \theta^{\beta^2},\ \text{etc.} \tag{75}$$

m being prime. The number of terms in the cycle is $(m-1)^2$. Let θ_1 be the $(m+1)^{\text{th}}$ term in the cycle (75), θ_2 the $(2m+1)^{\text{th}}$ term, and so on. Then the root of an equation of the m^{th} degree, including the instances above given, is

$$r_1 = (\theta + \theta^{-1}) + (\theta_1 + \theta_1^{-1}) + \ldots\ldots + (\theta_{\frac{m-3}{2}} + \theta_{\frac{m-3}{2}}^{-1}).$$

[*Read before the Canadian Institute, March 3rd, 1888*].

RESOLUTION

OF

SOLVABLE EQUATIONS OF THE FIFTH DEGREE,

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CONTENTS.

§1. By means of the laws established in the paper entitled "Principles of the Solution of Equations of the Higher Degrees;" which is concluded in the present issue of the Journal of Mathematics, a criterion of the solvability of equations of the fifth degree may be found, and the roots of solvable quintics obtained in terms of given numerical coefficients. In certain classes of cases, the roots can be determined in terms of coefficients to which particular numerical values have not been assigned, but which are only assumed to be so related as to make the equations solvable.

Sketch of the Method Employed.

§2. Let r_1, r_2, r_3, r_4, r_5, be the roots of the solvable irreducible equation of the fifth degree wanting the second term,

$$F(x) = x^5 + p_2 x^3 + p_3 x^2 + p_4 x + p_5 = 0. \tag{1}$$

It was proved in the "Principles" that

$$r_1 = \tfrac{1}{5}\left(\Delta_1^{\frac{1}{5}} + \Delta_2^{\frac{1}{5}} + \Delta_3^{\frac{1}{5}} + \Delta_4^{\frac{1}{5}}\right),$$

where Δ_1, Δ_2, Δ_3, Δ_4 are the roots of a biquadratic equation auxiliary to the equation $F(x) = 0$. It was also shown that the root can be expressed in the form

$$r_1 = \tfrac{1}{5}\left(\Delta_1^{\frac{1}{5}} + a_1 \Delta_1^{\frac{2}{5}} + e_1 \Delta_1^{\frac{3}{5}} + h_1 \Delta_1^{\frac{4}{5}}\right), \tag{2}$$

where a_1, e_1, h_1, involve only surds occurring in Δ_1; and no surds occur in Δ_1 except $\sqrt{(hz + h\sqrt{z})}$ and its subordinate $\sqrt{z}$; z being equal to $1 + e^2$, and h and e being rational. As in the "Principles," we may put $5u_1, = \Delta_1^{\frac{1}{5}}$, $5u_2 = \Delta_2^{\frac{1}{5}}$, $5u_3 = \Delta_3^{\frac{1}{5}}$, $5u_4 = \Delta_4^{\frac{1}{5}}$. Then

$$r_1 = u_1 + u_2 + u_3 + u_4\,. \tag{3}$$

Let S_1 be the sum of the roots of the equation $F(x) = 0$, S_2 the sum of their squares, and so on. Also let

$$\left.\begin{aligned}
\Sigma(u_1^2 u_3) &= u_1^2 u_3 + u_2^2 u_1 + u_3^2 u_4 + u_4^2 u_2\,,\\
\Sigma(u_1^3 u_2) &= u_1^3 u_2 + u_2^3 u_4 + u_3^3 u_1 + u_4^3 u_3\,,\\
\Sigma(u_1 u_3^2 u_4^2) &= u_1 u_3^2 u_4^2 + u_2 u_1^2 u_3^2 + u_3 u_4^2 u_2^2 + u_4 u_2^2 u_1^2\,;\\
\text{Then}\quad \Sigma(u_1^5) &= u_1^5 + u_2^5 + u_3^5 + u_4^5\,;\\
S_2 &= 10\,(u_1 u_4 + u_2 u_3),\ S_3 = 15\left\{\Sigma(u_1^2 u_3)\right\},\\
S_4 &= 20\left\{\Sigma(u_1^3 u_2)\right\} + \tfrac{3}{10}(S_2^2) + 60\,u_1 u_2 u_3 u_4\,,\\
S_5 &= 5\left\{\Sigma(u_1^5)\right\} + \tfrac{2}{3}(S_2 S_3) + 50\left\{\Sigma(u_1 u_3^2 u_4^2)\right\}.
\end{aligned}\right\} \tag{4}$$

§3. It was proved in the "Principles" that $u_1 u_4$ and $u_2 u_3$ are the roots of a quadratic equation. But

$$25\,u_1 u_4 = h_1 \Delta_1\,, \text{ and } 25\,u_2 u_3 = a_1 e_1 \Delta_1\,.$$

Therefore, because a_1, e_1, h_1, involve no surds that are not subordinate to $\Delta_1^{\frac{1}{5}}$, $\sqrt{z}$ is the only surd that can appear in $u_1 u_4$ and $u_2 u_3$. Consequently we may put

$$u_1 u_4 = g + a\sqrt{z}, \text{ and } u_2 u_3 = g - a\sqrt{z}, \tag{5}$$

where g, a, are rational. It scarcely needs to be pointed out that these forms are valid whether the surd $\sqrt{z}$ is irreducible or not. Now $S_2 = 10\,(u_1 u_4 + u_2 u_3) = -2\,p_2$. Therefore

$$g = -\tfrac{1}{10}\,(p_2). \tag{6}$$

Again, it was shown in the "Principles" that the four expressions $u_1^2 u_3$, $u_2^2 u_1$, $u_3^2 u_4$, $u_4^2 u_2$, are the roots of a biquadratic equation. And, by the same reasoning as that employed in the case of $u_1 u_4$ and $u_2 u_3$, the only surds that can appear in these expressions are $\sqrt{(hz + h\sqrt{z})}$, $\sqrt{(hz - h\sqrt{z})}$, and $\sqrt{z}$. Let $hz + h\sqrt{z} = s$, and $hz - h\sqrt{z} = s_1$. Then

$$\sqrt{s_1} = \left(\frac{\sqrt{z} - 1}{e}\right)\sqrt{s}, \text{ and } \sqrt{s}\,\sqrt{s_1} = he\sqrt{z}.$$

Hence the expressions $u_1^2 u_3$, $u_2^2 u_1$, $u_3^2 u_4$, $u_4^2 u_2$, may have their values exhibited in terms of $\sqrt{z}$ and either of the surds $\sqrt{s}$, $\sqrt{s_1}$. Put

$$\left.\begin{aligned}
u_1^2 u_3 &= k + c\sqrt{z} + (\theta + \varphi\sqrt{z})\sqrt{s},\\
u_4^2 u_2 &= k + c\sqrt{z} - (\theta + \varphi\sqrt{z})\sqrt{s},\\
u_2^2 u_1 &= k - c\sqrt{z} + (\theta - \varphi\sqrt{z})\sqrt{s_1},\\
u_3^2 u_4 &= k - c\sqrt{z} - (\theta - \varphi\sqrt{z})\sqrt{s_1};
\end{aligned}\right\} \tag{8}$$

where k, c, θ, φ, are rational. These coefficients must bear a relation to g, a, in (5). In fact, because

$$(u_1^2 u_3)\,(u_4^2 u_2) = (u_1 u_4)^2\,(u_2 u_3),$$

$$(g^2 - a^2 z)\,(g + a\sqrt{z}) = (k + c\sqrt{z})^2 - (\theta + \varphi\sqrt{z})^2\,(hz + h\sqrt{z}).$$

Equating the rational parts to one another, and also the irrational parts,

$$\left.\begin{aligned}
hz\,(\theta^2 + \varphi^2 z + 2\theta\varphi) &= k^2 + c^2 z - g\,(g^2 - a^2 z,\\
h\,(\theta^2 + \varphi^2 z + 2\theta\varphi z) &= 2kc - a\,(g^2 - a^2 z).
\end{aligned}\right\} \tag{9}$$

Because $s_2 = 15\,\{\Sigma\, u_1^2 u_3)\} = -3p_3$,

$$k = -\tfrac{1}{20}\,(p_3). \tag{10}$$

It will be convenient to retain the symbols g and k, whose values are given in (6) and (10). Again, because $u_1^3 u_2 = \dfrac{(u_1^2 u_3)\,(u_2^2 u_1)}{u_2 u_3}$, we have, from (5) and (8),

$$u_1^3 u_2 = \frac{g + a\sqrt{z}}{g^2 - a^2 z}\{k + c\sqrt{z} + (\theta + \varphi\sqrt{z})\sqrt{s}\}$$
$$\{k - c\sqrt{z} + (\theta - \varphi\sqrt{z})\sqrt{s_1}\}$$
$$= A + A'\sqrt{z} + (A'' + A'''\sqrt{z})\sqrt{s},$$

where A, A', A'', A''', are rational. The value of A is

$$A = \frac{1}{g_2 - a^2 z}\{g(k^2 - c^2 z) + ahez(\theta^2 - \varphi^2 z)\}. \tag{11}$$

Again, $u_1^5 = \dfrac{(u_1^2 u_3)^2 (u_2^2 u_1)}{(u_2 u_3)^2}$. That is, from (8) and (5) and (7).

$$u_1^5 = \frac{(g + a\sqrt{z})^2}{(g^2 - a^2 z)^2}\{2(k + c\sqrt{z})^2 - (g^2 - a^2 z)(g + a\sqrt{z})$$
$$+ 2(k + c\sqrt{z})(\theta + \varphi\sqrt{z})\sqrt{s}\}$$
$$\{k - c\sqrt{z} + (\theta - \varphi\sqrt{z})\sqrt{s_1}\}$$
$$= B + B'\sqrt{z} + (B'' + B'''\sqrt{z})\sqrt{s};$$

where B, B', B'', B''', are rational. Now, by (4),

$$S_4 = 20\{\Sigma(u_1^3 u_2)\} + \tfrac{3}{10}(S_2^2) + 60\, u_1 u_2 u_3 u_4.$$

And $S_4 = 2p_2^2 - 4p_4$. Also $\Sigma(u_1^3 u_2) = 4A$; and, by (6), $10g = -p_2$; and, by (5), $u_1 u_2 u_3 u_4 = g_2 - a_2 z$. Therefore

$$p_4 = -20A + 5g^2 + 15a^2 z. \tag{12}$$

Again, $S_5 = 5\{\Sigma(u_1^5)\} + \tfrac{5}{6}(S_2 S_3) + 50\{\Sigma(u_1 u_3^2 u_4^2)\}$.

And $\Sigma(u_1^5) = 4B$, $S_2 S_3 = 6\, p_2 p_3 = 1200\, gk$, and

$$\Sigma(u_1 u_3^3 u_4^2) = u_1 u_4(u_2^2 u_1 + u_3^2 u_4) + u_2 u_3(u_1^2 u_3 + u_4^2 u_2).$$

Therefore $S_5 = 20B + 1000gk - 200acz$.

But $S_5 - 5p_2 p_3 + 5p_5 = S_5 - 1000gk + 5p_5 = 0$.

Therefore
$$p_5 = -4B + 40acz. \tag{13}$$

The values of p_4 and p_5 in (12) and (13) make thè quintic

$$F(x) = x^5 + p_2 x^3 + p_3 x^2 + (5g^2 + 15a^2 z - 20A)x$$
$$+ (40acz - 4B) = 0. \tag{14}$$

§4. Assuming the coefficients p_2, p_3, etc., in (1), to be known, the coefficients in the equation $F(x) = 0$ as exhibited in (14) involve six unknown quantities, namely, a, c, θ, φ, e, h. The list does not

include z, g, k; because $z = 1 + e^2$; and g and k are known by (6) and (10). To find the six unknown quantities we have six equations, which are here gathered together.

$$\left.\begin{aligned} p_4 &= -20A + 5g^2 + 15a^2 z, \\ p_5 &= -4B + 40acz, \\ B'' &= 1, \\ B''' &= 0, \\ hz(\theta^2 + \varphi^2 z + 2\theta\varphi) &= k^2 + c^2 z - g(g^2 - a^2 z) \\ h(\theta^2 + \varphi^2 z + 2\theta\varphi z) &= 2kc - a(g^2 - a^2 z). \end{aligned}\right\} \quad (15)$$

The first two of these equations are the equations (12) and (13). As to the third and fourth, it was proved in the "Principles" that the form of u_1^5 is $m + n\sqrt{z} + \sqrt{(hz + h\sqrt{z})}$, m and n being rational. This is saying in other words that $B'' = 1$ and $B''' = 0$. The last two of the equations (15) are the equations (9).

§5. The criterion of solvability of the equation $F(x) = 0$ may now be stated in a general way to be that the coefficients p_2, p_3, etc., must be so related that rational quantities, a, c, θ, φ, e, h, exist satisfying the equations (15). We also see what requires to be done in order to find the roots of the equation $F(x) = 0$ in terms of the given coefficients. By (3), r_1 is known when u_1, u_2, u_3, u_4 are known. But, B'' and B''' being respectively unity and zero,

$$u_1^5 = B + B'\sqrt{z} + \sqrt{s}, \quad u_2^5 = B - B'\sqrt{z} + \sqrt{s_1},$$
$$u_4^5 = B + B'\sqrt{z} - \sqrt{s}, \quad u_3^5 = B - B'\sqrt{z} - \sqrt{s_1}.$$

Therefore, to find r_1 we need to find B, B', z and h; which is equivalent to saying that we need to find the six unknown quantities a, c, θ, φ, e, h. Before pointing out how this may be done in the most general case, I will refer to some special forms of soluble quintics.

CASE IN WHICH $u_1 u_4 = u_2 u_3$.

§6. A notable class of solvable quintics is that in which $u_1 u_4 = u_2 u_3$. It includes, as was proved in the "Principles," all the Gaussian equations of the fifth degree for the reduction of $x^n - 1 = 0$, n prime. It includes also other equations, of which examples will presently be given. Now, when $u_1 u_4 = u_2 u_3$, the root of the quintic can be found in terms of the coefficients p_2, p_3, etc., even while these coefficients retain their general symbolic forms; in other words, the root can be found in terms of p_2, p_3, etc., without definite numerical values being assigned to p_2, p_3, etc. This I proceed to show.

§7. By (5), because $u_1 u_4 = u_2 u_3$, $a = 0$. Thus, one of the six unknown quantities is determined, while we have still the six equations (15) to work with. It might be sufficient to say, that, from six equations five unknown rational quantities can be found. I will recur to this idea; but in the meantime the following line of reasoning may be pursued. From (11), $A = \dfrac{k^2 - c^2 z}{g}$. Therefore equation (12) becomes

$$gp_4 = -20(k^2 - c^2 z) + 5g^3. \tag{16}$$

Also, because $a = 0$, equations (7) being kept in view,

$$u_1^5 = \frac{1}{g^2}$$

$$\left\{2(k^2 - c^2z)(k + c\sqrt{z}) - g^3(k - c\sqrt{z}) + 2(k + c\sqrt{z})(\theta^2 - \varphi^2 z)he\sqrt{z}\right\}$$
$$+ B'' + B'''\sqrt{z})\sqrt{s}.$$

$$\therefore Bg^2 = k\left\{2(k^2 - c^2 z) - g^3\right\} + 2chez(\theta^2 - \varphi^2 z)$$

and $B'g^2 = c\left\{2(k^2 - c^2 z) + g^3\right\} + 2khe(\theta^2 - \varphi^2 z)$;

$$\therefore u_1^5 = \frac{1}{g^2}[k\{2(k^2 - c^2 z) - g^3\} + 2chez(\theta^2 - \varphi^2 z)]$$

$$+ \frac{\sqrt{z}}{g_2}[c\{2(k^2 - c^2 z) + g^3\} + 2khe(\theta^2 - \varphi^2 z)] + \sqrt{s}. \tag{17}$$

Substitute in the second of equations (15) the value of B that has been obtained. Then

$$g^2 p_5 = -4k\{2(k^2 - c^2 z) - g^3\} - 8chez(\theta^2 - \varphi^2 z). \tag{18}$$

The values of B'' and B''' are

$$\left.\begin{aligned} B'' eg^2 &= \theta\{M + 2e(k^2 - c^2 z)\} - \varphi z N = eg^2, \\ B''' eg^2 &= \theta N - \varphi\{M - 2e(k^2 c^2 z)\} = 0; \end{aligned}\right\} \tag{19}$$

$$\left.\begin{aligned} &\text{where } M = -2(k^2 + c^2 z) + g^3 + 4kcz, \\ &\text{which may be written } M = 5kcz - P, \\ &\text{and } N = 2(k^2 + c^2 z) - g^3 - 4kc, \\ &\text{which may be written } N = P - 4kc. \end{aligned}\right\} \tag{20}$$

The two equations (19) give us

$$\left.\begin{aligned} &\theta\{M^2 - zN^2 - 4e^2(k^2 - c^2 z)^2\} = eg^2\{M - 2e(k^2 - c^2 z)\}, \\ &\varphi\{M^2 - zN^2 - 4e^2(k^2 - c^2 z)^2\} = eg^2 N. \\ &\text{Therefore} \\ &\frac{\theta}{\varphi} = \frac{M - 2e(k^2 - c^2 z)}{N}. \end{aligned}\right\} \tag{21}$$

Equating the value of $\dfrac{\theta^2 + \varphi^2 z + 2\theta\varphi}{\theta^2 + \varphi^2 z + 2\theta\varphi z}$ obtained from (21) with that derived from the last two of equations (15),

$$\frac{k^2 + c^2 z - g^3}{2kcz} =$$
$$\frac{\{M - 2e(k^2 - c^2 z)\}^2 + N^2 z + 2N\{M - 2e(k^2 - c^2 z)\}}{\{M - 2e(k^2 - c^2 z)\}^2 + N^2 z + 2Nz\{M - 2e(k^2 - c^2 z)\}}. \quad (22)$$

The coefficients p_2, p_3, etc., in the equation $F(x) = 0$, being given, g and k are known by (6) and (10). Therefore, by (16), $c^2 z$ is known. Then (22) will be found to be a quadratic equation determinative of c. For, keeping in view the value of P in (20), (22) may be written

$$\frac{k^2 + c^2 z - g^3}{2kc^2 z} =$$
$$\frac{\{4(k^2 + c^2 z)^2 + P^2\} - 8kPc - 16k(k^2 - c^2 z)(ce)}{\{4(k^2 - c^2 z)^2 - 16k^2 c^2 z - P^2\} c + 8kc^2 zP - 4(k^2 - c^2 z)P(ce)}$$

Because g, k, $c^2 z$ and P are known, this equation is of the form

$$H(ce) = Kc + L,$$

where H, K, L, are known. Therefore, since $c^2 e^2 = c^2 z - c^2$,

$$c^2(H^2 + K^2) + 2KLc + (L^2 - H^2 c^2 z) = 0;$$

from which c is known. Therefore, since $c^2 z$ is known, z is known. Therefore e is known. Therefore, by (21), θ and φ are known. Therefore, by (18) or either of the equations (9), h is known. Therefore, by (17), u_1^5 is known. In like manner, u_2^5, u_3^5, u_4^5, are known. Hence finally, by (3), r_1 is known.

§8. *Example First.* I will now give some numerical verifications of the theory. The Gaussian equation of the fifth degree for the reduction of $x^{11} - 1 = 0$, when deprived of its second term, is

$$x^5 - \frac{22}{5}x^3 - \frac{11}{25}x^2 + \frac{11 \times 42}{125}x + \frac{11 \times 89}{3125} = 0.$$

When a root of this equation is expressed as in (1), the value of r_1, as given by Lagrange, is

$$u_1^5 = \frac{11}{4(5)^5}\{-89 - 25\sqrt{5} + 5(19 - 9\sqrt{5})(-5 - 2\sqrt{5})\};$$

which, reduced to the form that we have adopted, is

$$u_1^5 = \frac{11}{4(5)^5}\left\{-89 + 25 \times \frac{89}{41}\sqrt{\left(\frac{5 \times 41^2}{89^2}\right)}\right\} + \sqrt{(hz + h\sqrt{z})};$$

where $h = -\dfrac{11^2 \times 89^2}{8 \times 41 \times (5)^8}, \sqrt{z} = -\dfrac{41}{89}\sqrt{5}$, and $e = -\dfrac{22}{89}$.

We have to show that this is the result to which the equations of the preceding section lead. The simplest way will be to find g, k and c^2z by means of (6), (10) and (16), and then to take the values of e and $\sqrt{z}$ given above, and to substitute them in equation (22). If the theory is sound, the equation ought in this way to be satisfied. When this equation has been satisfied, it will be unnecessary to pursue the verification farther. Because

$$p_2 = -\frac{22}{5}, \text{ and } p_3 = -\frac{11}{25}, \ g = \frac{11}{25} \text{ and } k = \frac{11}{20 \times 25}.$$

From (18), taken in connection with (21), che must be negative. Therefore

$$c = -\frac{11 \times 89}{4 \times 25 \times 41}, \quad kc = -\frac{89}{80 \times 41}\left(\frac{11}{25}\right)^2,$$

$$kcz = -\frac{41}{16 \times 89}\left(\frac{11}{25}\right)^2, \quad k^2 - c^2 z = -\frac{31}{100}\left(\frac{11}{25}\right)^2,$$

$$M = -\frac{2716}{89 \times 100}\left(\frac{11}{25}\right)^2, \quad N = \frac{1224}{41 \times 100}\left(\frac{11}{25}\right)^2,$$

$$M - 2e\,(k^2 + c^2 z) = -\frac{4080}{89 \times 100}\left(\frac{11}{25}\right)^2.$$

These values reduce the equation (22) to the identity

$$\frac{89}{41} = \frac{89}{41}\left\{\frac{41\,(4080^2 + 5 \times 1224^2) - 89\,(2448 \times 4080)}{89\,(4080^2 + 5 \times 1224^2) - 205\,(2448 \times 4080)}\right\}.$$

§9. *Example Second.* The example that has been given is one in which the auxiliary biquadratic is irreducible, I will now take an example,

$$x^5 + 10x^3 - 80x^2 + 145x - 480 = 0, \tag{23}$$

in which the auxiliary biquadratic has a sub-auxiliary quadratic. When the root of the equation (23) is put in the form (1),

$$u_1 = (1 + \sqrt{2})^{\frac{1}{5}}, \ u^4 = (1 - \sqrt{2})^{\frac{1}{5}},$$

$$u_2 = (1 + \sqrt{2})\,(1 + \sqrt{2})^{\frac{2}{5}},$$

$$u_3 = (1 - \sqrt{2})\,(1 - \sqrt{2})^{\frac{2}{5}},$$

the product of the roots $(1+\sqrt{2})^{\frac{1}{5}}$, $(1-\sqrt{2})^{\frac{1}{5}}$, being -1. Putting β for 28560, and λ for 28562,

$$g=-1,\ k=4,\ c\sqrt{z}=-3,\ z=\frac{\lambda^2}{\beta^2},\ c=\frac{3\beta}{\lambda},$$

$$k^2+c^2 z=25,\ kc=\frac{12\beta}{\lambda},\ kcz=\frac{12\lambda}{\beta},$$

$$P=2\,(k^2+c^2 z)-g^3=51,$$

$$M=\frac{48\lambda-51\beta}{\beta},\ N=\frac{51\lambda-48\beta}{\lambda},$$

$$M-2e\,(k^2-c^2 z)=\frac{48\lambda-51\beta+14\times 338}{\beta}.$$

These values cause (22) to become

$$\frac{13}{12}=\frac{\lambda\left\{Q^2+(51\lambda-48\beta)^2\right\}+2\beta\,(51\lambda-48\beta)\,Q}{\beta\left\{Q^2+(51\lambda-48\beta)^2\right\}+2\lambda\,(51\lambda-48\beta)\,Q}$$

where $Q=48\lambda-51\beta+14\times 338$. This may be written

$$\frac{13}{12}=\frac{H\lambda+2K\beta}{H\beta+2K\lambda}.$$

In order that this equation may subsist, it is necessary that

$$H\,(13\beta-12\lambda)=2K\,(12\beta-13\lambda);$$

$$\text{or } \frac{H}{2}\left(\frac{\beta-24}{2}\right)=-\frac{K\,(\beta+26)}{2}.$$

But $H=(-80852)^2+(85782)^2=6537045904+7358551524$ $=13895597428$; $-K=(80852)\,(85782)=6935646264$; $\frac{\beta-24}{2}$ $=14268$; $\frac{\beta+26}{2}=14293$; and $6947798714\times 14268=6935646264$ $\times\ 14293=99131192051352$.

§10. *Example Third.* I will finally take an example,

$$x^5+20x^3+20x^2+30x+10=0, \tag{24}$$

in which the roots of the auxiliary biquadratic are all rational. By (6) and (10) and (16), $g=-2$, $k=-1$, $c^2 z=0$. Therefore the denominator of the expression on the left of (22) is zero, while the numerator is not zero. Therefore the denominator of the expression on the right of (22) is zero. Or, $-g^6+4k^2g^3-8ek^4+4eg^3k^2=0$. Therefore $e=-\frac{12}{5}$. Therefore $z=\left(\frac{13}{5}\right)^2$, and $c=0$. Hence $M=-10$, $N=10$; and, if

$$D = M^2 - zN^2 - 4e^2 (k^2 - c^2 z)^2,$$

$$D = -104e^2. \text{ Therefore, by (21), } \theta = -\frac{1}{12},$$

$$\varphi = \frac{25}{12 \times 13}, \ \theta^2 - \varphi^2 z = -\frac{1}{6}. \text{ Therefore by (9), } h = \frac{225}{26}.$$

Therefore using the symbols, B, B', as in §3,

$$B = -\frac{5}{2}, \ B' = -\frac{45}{26}, \ s = h (z + \sqrt{z}) = 81,$$

$$s_1 = h (z - \sqrt{z}) = 36.$$

Therefore $\quad u_1^5 = -7 + 9 = 2, \ u_4^5 = -7 - 9 = -16,$

$\qquad u_2^5 = 2 - 6 = -4, \ u_3^5 = 2 + 6 = 8.$

Hence, by (3),

$$r_1 = 2^{\frac{1}{5}} - 2^{\frac{2}{5}} + 2^{\frac{3}{5}} - 2^{\frac{4}{5}};$$

which is the solution of the equation (24).

§11. It was pointed out in §7 that, in the case we are considering, there are six equations and five unknown quantities. All the unknown quantities may be eliminated, and an equation $p' = 0$ obtained; where p' is a rational function of the coefficients p_2, p_3, etc. This elimination has been performed, under the direction of the author of the paper, by Mr. Warren Reid of Toronto, with the following result. Putting P, as in §7, for $2 (k^2 + c^2 z) - g^3$, let

$$A = -2kc^2 zg^3 \{8 (k^2 + c^2 z) - 3g^3\},$$
$$B = g^3 \{16k^2 c^2 z + 4 (k^2 + c^2 z)^2 - 5g^3 (k^2 + c^2 z) + g^6\},$$
$$D = -4 (k^2 - c^2 z) \{-g^6 + 3g^3 (k^2 + c^2 z) - 2 (k^2 - c^2 z)^2\},$$
$$A_1 = -8kc^2 z[32kc^2 z(k^2 - c^2 z) - P \{p_5 g^2 + 8k(k^2 - c^2 z) - 4kg^3\}]$$
$$B_1 = \{p_5 g^2 + 8k(k^2 - c^2 z) - 4kg^3\}[-32k^2c^2z + g^3\{4(k^2 + c^2 z) - g^3\}]$$
$$+ 64kc^2 z P (k^2 - c^2 z),$$
$$D_1 = -16kc^2 zg^3 \{4 (k^2 + c^2 z) - g^3\}$$
$$+ 4P (k^2 - c^2 z) \{p_5 g^2 + 8k (k^2 - c^2 z) - 4kg^3\}.$$

Then, since $10g = -p_2$, and $20k = -p_3$, and

$$20c^2 z = p_4 g - 5g^3 + 20k^2,$$

the quantities A, B, D, A_1, B_1, D_1, are known rational functions of p_2, p_3, etc. And

$$(B^2+D^2)(A_1^2-D_1^2c^2z)-(B_1^2+D_1^2)(A^2-D^2c^2z)$$
$$+\,4\{AB(B_1^2+D_1^2)-A_1B_1(B^2+D^2\}$$
$$.\{AB(A_1^2-D_1^2c^2z)-A_1B_1(A^2-D^2c^2z)\}=0. \qquad (25)$$

§12. To verify this result, the Gaussian equation in §8 may be used. Here

$$A=-\frac{11^6}{2^5\times 5^{12}}\left(\frac{11^3+11^2\times 19}{5^6}\right)=-\frac{11^8\times 3}{2^4\times 5^{17}}$$

$$B=\frac{11^3}{5^6}\left(\frac{11^4}{2^4\times 5^9}+\frac{3^4\times 7^2\times 11^4}{2^4\times 5^{12}}-\frac{9\times 35\times 11^5}{8\times 5^{12}}+\frac{11^6}{5^{12}}\right)$$
$$=-\frac{9\times 11^7}{4\times 5^{16}}.$$

$$D=\frac{11^2\times 31}{5^{18}}\left(-11^6+\frac{7\times 27\times 11^5}{8}-\frac{31^2\times 11^4}{8}\right)$$
$$=\frac{3\times 31\times 11^6}{4\times 5^{16}}.$$

$$A_1=\frac{11^8}{2^6\times 5^{18}}(19+31)=\frac{11^8}{2^5\times 5^{16}}$$

$$B_1=\frac{11^7}{2^4\times 5^{18}}(-5^3+44\times 41-19\times 31)=\frac{11^7\times 109}{8\times 5^{17}}$$

$$D_1=-\frac{11^6}{4\times 5^{12}}\left(\frac{63\times 11^2}{2\times 5^6}-\frac{11^3}{5^6}\right)-\frac{11^7\times 19\times 31}{8\times 5^{18}}$$
$$=-\frac{11^7\times 26}{5^{17}}$$

Therefore

$$B^2+D^2=\frac{9\times 11^{12}\times 41}{8\times 5^{30}},\quad B_1^2+D_1^2=\frac{11^4\times 11029}{2^6\times 5^{35}},$$

$$A^2-D^2c^2z=-\frac{9\times 11^{14}\times 89}{2^6\times 5^{35}},$$

$$A_1^2-D_1^2c^2z=-\frac{11^{16}\times 40139}{2^{10}\times 5^{37}}.$$

By the substitution of these values, equation (25) becomes

$$\frac{11^{56} \times 3^4}{2^{26} \times 5^{136}} \{ 6265333^2 - 2886277 \times 13600357 \} =$$
$$\frac{11^{56} \times 3^4}{2^{26} \times 5^{136}} \{ 39254397600889 - 39254397600889 \} = 0.$$

§13. As an additional verification, the equation

$$x^5 + 10x^3 - 80x^2 + 145x - 480 = 0$$

may be taken. Here, by §9,

$$g = -1,\ k = 4,\ k^2 - c^2 z = 7,\ k^2 + c^2 z = 25.$$

Therefore

$$A = 2^3 \times 3^2 \times 7 \times 29,\ B = -2 \times 5 \times 17 \times 29,$$
$$D = 2^3 \times 3 \times 7 \times 29,$$
$$A_1 = -2^9 \times 3^4 \times 141,\ B_1 = 2^4 \times 3 \times 17 \times 2393,$$
$$D_1 = -2^7 \times 3^2 \times 13 \times 19.$$
$$B^2 + D^2 = 2^2 \times 29^2 \times 14281,$$
$$B_1^2 + D_1^2 = 2^8 \times 3^2 \times 5 \times 338016989,$$
$$A^2 - D^2 c^2 z = 0,$$
$$A_1^2 - D_1^2 c^2 z = 2^{14} \times 3^6 \times 5 \times 7 \times 17^2 \times 277.$$

By the substitution of these values, equation (25) becomes

$$2^{18} \times 3^6 \times 5 \times 7 \times 17^2 \times 29^4 \{ 277 \times 14281^2 + 5^7 \times 7 \times 338016989 - 2^8 \times 3 \times 141 \times 2393 \times 14281 \} = 0.$$

The Trinomial Quintic $x^5 + p_4 x + p_5 = 0$.

§14. In this case, by (6) and (10), $g = 0$, and $k = 0$. Therefore, by (11), $A = -\dfrac{he(\theta^2 - \varphi^2 z)}{a}$. Therefore, by (12),

$$p_4 = \frac{20he(\theta^2 - \varphi^2 z)}{a} + 15a^2 z. \quad (26)$$

Also, by §3, $B = \dfrac{1}{a^2 z} \{ -a^3 z^2 c + 2hecz(\theta - \varphi^2) \}$. Therefore, by (13),

$$p_5 = -\frac{8hec}{a^2}(\theta^2 - \varphi^2 z) + 44acz. \quad (27)$$

Hence the quintic becomes

$$F(x) = x^5 + \left\{ \frac{20he\,(\theta^2 - \varphi^2 z)}{a} + 15a^2 z \right\} x$$
$$+ \left\{ -\frac{8hec}{a^2}(\theta^2 - \varphi^2 z) + 44acz \right\} = 0. \qquad (28)$$

The criterion of solvability of a trinomial quintic of the kind under consideration is therefore that the coefficients p_4 and p_5 be related in the manner indicated in the form (28); while at the same time the last four of the equations (15), modified by putting $g = k = 0$, subsist between the rational quantities $a, c, e, h, \theta, \varphi$. From these data, the three following equations may be deduced, v being put for $\frac{c^2}{a^3}$:

$$\left.\begin{aligned} &8ev^3 - 4zv^2 + z(3 - 4e)v - z^2 = 0, \\ &\frac{2p_4}{a^2} + \frac{5p_5}{ac} = 250z, \\ &4v(ze + 4zv - 8v^2) = \left(-3z + \frac{p_4}{5a^2}\right)\{z + 4v(e-1) + 8v^2\}. \end{aligned}\right\} \quad (29)$$

The first of these equations is obtained from a comparison of the two equations (9), the second is obtained by putting p_4 and p_5 respectively equal to the values they have in (28); and the third is obtained by putting p_4 equal to the coefficient of the first power of x in (28).

§15. If any rational values of e and v can be found satisfying the first of equations (29), let such values be taken. Then, from the second and third of (29), a^2 and ac can be found. Therefore a and c are known. Therefore, by (21), θ and φ are known. Therefore, by (9), h is known. In this way all the elements for the solution of the quintic are obtained.

§16. For example, the three equations (29) are satisfied by the values

$$e = \frac{1}{2},\ z = v = \frac{5}{4},\ c = \frac{25}{2},$$
$$a = 5, \therefore \theta = 0,\ \varphi = -\frac{4}{75},\ h = \frac{45 \times 25^3}{16}.$$

When these values are substituted in (28), the quintic becomes

$$x^5 + \frac{625x}{4} + 3750 - 0.$$

Then the values of u_1^5, u_2^5, u_3^5, u_4^5, obtained from the expression for u_1^5, in §3, are

$$u_1^5 = \frac{625}{4}\left\{-1-\sqrt{\left(\frac{5}{4}\right)}+\frac{3}{\sqrt{5}}\sqrt{\left(\frac{5}{4}+\sqrt{\frac{5}{4}}\right)}\right\},$$

$$u_4^5 = \frac{625}{4}\left\{-1-\sqrt{\left(\frac{5}{4}\right)}-\frac{3}{\sqrt{5}}\sqrt{\left(\frac{5}{4}+\sqrt{\frac{5}{4}}\right)}\right\},$$

$$u_2^5 = \frac{625}{4}\left\{-1+\sqrt{\left(\frac{5}{4}\right)}-\frac{3}{\sqrt{5}}\sqrt{\left(\frac{5}{4}-\sqrt{\frac{5}{4}}\right)}\right\},$$

$$u_3^5 = \frac{625}{4}\left\{-1+\sqrt{\left(\frac{5}{4}\right)}+\frac{3}{\sqrt{5}}\sqrt{\left(\frac{5}{4}-\sqrt{\frac{5}{4}}\right)}\right\}.$$

Hence, $r_1 = u_1 + u_2 + u_3 + u_4 = -1.52887 - 2.25035 + 2.48413 - 3.65639 = -4.95148.$

When any Relation is Assumed between the Six Unknown Quantities.

§17. In the case in which $u_1 u_4$ was taken equal to $u_2 u_3$ a relation was in fact assumed betwixt the six unknown quantites a, c, e, h, θ, φ; for, as we saw, to put $u_1 u_4 = u_2 u_3$ is tantamount to putting $a = 0$. Hence, as was noticed in §7, we had only five unknown quantities to be found from six equations. Now, when any relation whatever is assumed betwixt the six unknown quantities, the root of the quintic can be found in terms of the given coefficients p_2, p_3, etc., without any definite numerical values being assigned to the coefficients, because six rational quantities can always be found from seven equations.

The General Case.

§18. We have hitherto been dealing with solvable quintics, assumed to be subject to some condition additional to what is involved in their solvability. We have now to consider how the general case is to be dealt with. That is to say, we here make no supposition regarding the equation of the fifth degree $F(x) = 0$ except that it wants the second term and is solvable algebraically. In this case it is impossible to find the roots in terms of the coefficients p_2, p_3, etc., while these coefficients retain their general symbolic forms. But the equations in §3 enable us to find the roots when the coefficients receive any definite numerical values that render the equation solvable. For, we have the six equations (15) to determine the six unknown quantities a, c, e, h, θ, φ; and we can eliminate five of the unknown quantities,

and obtain an equation involving only one unknown quantity. The unknown quantity appearing in this equation has a rational value; but there are known methods of finding the rational roots of any algebraical equation with definite numerical coefficients. Therefore the unknown quantity can be found. In this way all the six unknown quantities a, c, e, h, θ, φ, can be found. Hence the roots of the quintic can be found.

§19. *Note.*—From my friend, Mr. J. C. Glashan, of Ottawa, who read in manuscript the paper on the "*Principles of the Solution of Equations of the Higher Degrees*," but did not see the present paper on the "*Resolution of Solvable Equations of the fifth Degree*," I learn that, setting out from propositions demonstrated in the "Principles," he has arrived at important conclusions in the theory of Quintics, which will be made public without delay; but he has not communicated to me either his method or the results he has obtained.

PROCEEDINGS

OF

THE CANADIAN INSTITUTE,

SESSION 1884.

NINTH ORDINARY MEETING.

The Ninth Ordinary Meeting of the Session 1883-4 was held on Saturday, January the 12th, the President in the chair.

The minutes of last meeting were read and confirmed.

Mr. James Bain, jun. and Mr. John Notman, were appointed to represent the Institute on the Board of the Industrial Exhibition Association.

The Rev. William Clark of Trinity College was elected a member.

The following list of donations and exchanges were presented:

1. Transactions of the Royal Geological Society of Cornwall, Vol. X, Part 5.
2. Science, Vol. II, Nos. 46, 47 and 48.
3. The Ornithologist and Oölogist, for Jan., 1884.
4. Proceedings of the Royal Geographical Society for December, 1883.
5. Transactions of the Royal Scottish Society of Arts, Vol. XI, Part 1.
6. Science Record, Vol. II, No. 2, Dec. 15th, 1883.
7. Historical Collections of the Essex Institute, Vol. XX, Nos. 1 to 9, Jan. to Sept., 1883.
8. Journal of the Royal Microscopical Society, Vol. III, Part 6, Dec., 1883.
9. Journal of the Franklin Institute, for Jan., 1884.
10. Journal of the Transactions of the Victoria Institute, Vol. XVII, No. 67.
11. The Canadian Practitioner, Jan., 1884.
12. Micrometry, Reprinted from the Proceedings of the American Society of Microscopists, Chicago Meeting, 1883.
13. An Examination of some Controverted Points of the Physiology of Voice, by J. Wesley Mills, M. A., M. D. Read before the American Association for the Advancement of Science at Montreal, Aug., 1882.

14. Proceedings of the Philosophical Society of Glasgow, Vol. XIV.
15. The Canadian Entomologist for Nov., 1883.
16. Bulletin de la Société Géologique de France, Vol. XII, No. 1.
17. Mémoires des Travaux de la Société des Ingénieurs Civils for Oct., 1883.
18. Transactions of the Manchester Geological Society, Vol. XVII, Part II.

Prof. R. Ramsay Wright, then presented the substance of a paper on the "Nervous System of the Cat-fish." Special attention was directed to the 'clavate' cells of the epidermis, to the branching of the fifth nerve, and to the relation existing between the air-bladder and the auditory organ. The paper is the first of a series on the cat-fish (*amiuras catus*) and will appear in a subsequent fasciculus of the Proceedings.

TENTH ORDINARY MEETING.

The Tenth Ordinary Meeting of the Session 1883-'84, was held on Saturday, the 19th of January, the President in the chair.

The minutes of last meeting were read and confirmed.

The following gentlemen were elected members of the Institute:—R. E. Kingsford, M.A.; Mr. D. O'Brooke, and Mr. J. Alfred Wilson.

The following list of donations and exchanges was read by the Hon. Secretary:

1. Science, Vol. III., No. 49, for January 11, 1884.
2. Journal of Speculative Philosophy, Vol. XVII., No. 4, October, 1883.
3. Proceedings of the Royal Geographical Society, Vol. VI., No. 1, Jan., 1884.
4. Trübner's American, European, and Oriental Literary Record, Vol. IV., Nos. 9 to 10, September to October, 1883.

Mr. W. Waugh Lauder then read a paper entitled, "The History of Musical Instruments." The instruments specially noticed were the Piano, Violin and Organ. In the discussion which followed, Mr. Notman, Mr. Wm. Anderson, Mr. Geo. E. Shaw, Mr. Paul Frind and Mr. Geo. Murray, took part.

ELEVENTH ORDINARY MEETING.

The Eleventh Ordinary Meeting of the Session 1883-'84, was held on Saturday, January the 26th, 1884, the Second Vice-President, Mr. Geo. Murray, in the chair.

The Minutes of last meeting were read and confirmed.

Mr. Stephen Nairn and Dr. John McConnell were elected members of the Institute.

The following list of donations and exchanges was read by the Hon. Secretary:

1. Science, Vol. III., No. 50, January 18th, 1884.
2. The Monthly Weather Review for December.
3. Map of Winnipeg and environs, by Alan Macdougall, Esq., C. E., F.R.S.E. Presented by the author.
4. Proceedings of the Boston Society of Natural History, Vol. XXII., Part 2, Nov., 1882, to Feb., 1883.

The President, Mr. J. M. Buchan, then read a paper entitled "Flora Hamiltonensis," a list of plants collected in the vicinity of Hamilton.

FLORA HAMILTONENSIS.

In preparing this list I have adopted the classification and nomenclature employed by Professor Gray, in the fifth edition of his Manual. Plants, the names of which are marked with an asterisk, are admitted on the authority of the late Judge Logie. All plants included occur within seventeen miles of Hamilton:—

RANUNCULACEÆ.

Clematis verticillaris, DC. Chedoke.
" Virginiana, L.
Anemone cylindrica, Gray.
" Virginiana, L.
" Pennsylvanica, L.
" nemorosa, L.
* " nemorosa, L., var. quinquefolia. Oaklands.
Hepatica triloba, Chaix.
" acutiloba, DC.
Thalictrum anemonoides, Mx.
" dioicum, L.
" Cornuti, L.
Ranunculus aquatilis, L., var. trichophyllus, Chaix.
* " multifidus, Pursh.
" abortivus, L.
" sceleratus, L.

RANUNCULACEÆ—*Continued.*

Ranunculus recurvatus, Poir.
" Pennsylvanicus, L. Also at Fullarton.
" fascicularis, Muhl. Also at Walkerton.
" repens, L.
" bulbosus, L.
" acris, L.
Caltha palustris, L.
Coptis trifolia, Salisb.
Aquilegia Canadensis, L.
Delphinium Consolida, L.
Actaea spicata, L. var. rubra, Mx.
" alba, Bigel.

MAGNOLIACEÆ.

Liriodendron tulipifera, L.

MENISPERMACEÆ.

Menispermum Canadense, L.

BERBERIDACEÆ.

* Berberis vulgaris, L.
Caulophyllum thalictroides, Mx.
Podophyllum peltatum, L.

NYMPHÆACEÆ.

Nymphæa tuberosa, Paine.
Nuphar advena, Ait.

SARRACENIACEÆ.

Sarracenia purpurea, L.

PAPAVERACEÆ.

Papaver argemone, L.
Chelidonium majus, L.
Sanguinaria Canadensis, L.

FUMARIACEÆ.

* Adlumia cirrhosa, Raf. Rare.
Dicentra cucullaria, DC.
" Canadensis, DC.
* Fumaria officinalis, L. Burlington Beach.

CRUCIFERÆ.

Nasturtium officinale, R. Br.
" silvestre, R. Br., Dundas.
" palustre, DC.
" " " var. hispidum.
Dentaria diphylla, Mx.
" heterophylla, Nutt.
" laciniata, Muhl.
Cardamine rhomboidea, DC.
* Cardamine rhomboidea, DC. var. purpurea, Torr.
* Cardamine patensis, L. Millgrove.
" hirsuta, L.
Arabis hirsuta, Scop.
" laevigata, DC.
" Canadensis, L.
Erysimum cheiranthoides, L.
Sisymbrium officinale, Scop.
" canescens, Nutt. Burlington Beach.
Brassica sinapistrum, Boissier.
" nigra, Gray.
Camelina sativa, Crantz. Also at Paris.
Capsella Bursa-pastoris, Moench.
Lepidium Virginicum, L.
" ruderale, L.
" campestre, L.
Cakile Americana, Nutt.

CAPPARIDACEÆ.

Polanisia graveolens, Raf.

VIOLACEÆ.

Viola blanda, Willd.
" cucullata, Ait.
" " " var. cordata.
* " sagittata, Ait. The Cemetery.

VIOLACEÆ—*Continued.*

Viola canina L. var. silvestris, Regel.
" rostrata, Pursh.
" Canadensis, L.
" pubescens, Ait.

CISTACEÆ.

Helianthemum Canadense, Mx.
Lechaea minor, Lam.

DROSERACEÆ.

* Drosera rotundifolia, L. Ancaster.

HYPERICACEÆ.

* Hypericum Kalmianum, L.
* " ellipticum, Hook. Freeman's Lot.
" perforatum, L.
" corymbosum, Muhl.
" mutilum, L.
Elodes Virginica, Nutt.

CARYOPHYLLACEÆ.

Saponaria officinalis, L.
* Silene inflata, Smith.
" antirrhina, L.
" noctiflora, L.
Lychnis Githago, Lam.
Arenaria serpyllifolia, L. Also at St. Thomas.
" stricta, Mx.
* " lateriflora, L. Burlington Beach.
Stellaria media, Smith.
" longiflora, Muhl.
" longipes, Goldie.
Cerastium vulgatum, L.
" viscosum, L.
* " oblongifolium, Torr. [Query.] Woods behind Captain Nichols's Farm.
" arvense, L.

PORTULACACEÆ.

Portulaca oleracea, L.
" grandiflora, Hook.
Claytonia Virginica, L.

MALVACEÆ.

Malva rotundifolia, L.
" moschata, L.
Abutilon Avicennæ, Gaertn. Dundas. Mouth of Stony Creek.

TILIACEÆ.

Tilia Americana, L.

LINACEÆ.

Linum Virginianum, L.

GERANIACEÆ.

Geranium maculatum, L.
" pusillum, L.
" Robertianum L.

GERANIACEÆ—*Continued.*

Erodium Cicutarium, L'Her.
Impatiens pallida, Nutt.
" fulva, Nutt.
Oxalis stricta, L.

RUTACEÆ.

Xanthium Americanum, Mill.

ANACARDIACEÆ.

Rhus typhina, L.
" toxicodendron, L.
" " " var. radicans. Mountain, above Reservoir.

VITACEÆ.

Vitis Labrusca, L. Mountain, East of Reservoir.
" cordifolia, Lam.
" cordifolia, Lam., var. riparia, Gray. This well-marked variety is very common, but I have never seen it in either flower or fruit.
Ampelopsis quinquefolia, Mx.

RHAMNACEÆ.

* **Rhamnus alnifolia, L'Her.** Millgrove.
Ceanothus Americanus, L.

CELASTRACEÆ.

Celastrus scandens, L.
Euonymus Americanus L., var. obovatus, Torr. and Gray.

SAPINDACEÆ.

Staphylea trifolia, L.
Acer spicatum, Lam.
" saccharinum, Wang.
" dasycarpum, Ehrhart.
" rubrum, L.

POLYGALACEÆ.

* **Polygala Nuttallii, Torr. and Gray.** [Query.] Prince's Island.
" verticillata, L.
" Senega, L.
" paucifolia, Willd.

LEGUMINOSÆ.

Trifolium arvense, L.
" pratense, L.
" repens, L.
Melilotus officinalis, Willd.
" alba, Lamm.
Medicago lupulina, L.
Robinia Pseudacacia, L.
Astragalus Canadensis, L.
" Cooperi, Gray.
Desmodium nudiflorum, DC.
" acuminatum, DC.

LEGUMINOSÆ—*Continued.*

Desmodium cuspidatum, Torr. & Gr.
" paniculatum, DC.
" Canadense DC.
* **Lespedeza repens, Torr. and Gray.** The Dell, Ancaster.
* " violacea, Pers. The Dell, Ancaster.
" hirta, Ell.
" capitata, Mx.
* **Vicia hirsuta, Koch.**
Lathyrus maritimus, Bigelow.
* " pratensis, L. Ancaster.
" ochroleucus, Hook.
" palustris, L.
" palustris, L., var. myrtifolius, Gray. Also at Toronto.
Apios tuberosa, Moench.
Phaseolus diversifolius, Pers.
Amphicarpæa monoica, Nutt.
* **Baptisia tinctoria, R. Br.**

ROSACEÆ.

Prunus Americana, Marshall.
" Pennsylvanica, L.
" Virginiana, L.
" serotina, Ehrhart.
* **Spiræa salicifolia, L.** Millgrove.
Gillenia trifoliata, Moench.
Agrimonia Eupatoria, L.
Geum album, Gmelin.
" strictum, Ait.
" rivale, L.
Waldsteinia fragarioides, Tratt.
Potentilla Norvegica, L.
" paradoxa, Nutt.
" Canadensis, L.
" argentea, L. Also at Paris.
" anserina, L.
" palustris, Scop.
Fragaria Virginiana, Ehrhart.
" vesca, L.
* **Dalibarda repens, L.**
Rubus odoratus, L.
" triflorus, Richardson.
" strigosus, Mx.
" occidentalis, L.
" villosus, Ait.
" Canadensis, L.
Rosa Carolina. L.
" lucida, Ehrhart.
" blanda, Ait.
" rubiginosa, L.
* " micrantha, Smith.
Cratægus oxyacantha, L. Spontaneous on bluff overlooking Dundas Marsh.
" coccinea, L.

ROSACEÆ—*Continued.*

Cratægus tomentosa, L.
" tomentosa, L., var. pyrifolia, Gray.
" Crus-Galli, L.
Pyrus coronaria, L.
* " arbutifolia, L., var. melanocarpa. Millgrove Marsh.
" aucuparia, Gærtn. Apparently indigenous near Dundas Marsh.
Amelanchier Canadensis, Torr. and Gray, var. Botryapium, Gray.
" Canadensis, Torr. and Gray, var. rotundifolia, Gray.
" Canadensis, Torr. and Gray, var. oblongifolia, Gray.
" Canadensis, Torr. and Gray, var. with notched petals 2-4 feet high flowering a few days later than the preceding variety.

SAXIFRAGACEÆ.

Ribes cynosbati, L.
* " hirtellum, Mx.
" rotundifolium, Mx.
" lacustre, Poir.
" floridum, L.
* " rubrum, L. Millgrove.
Saxifraga Virginiensis, Mx.
*Parnassia Caroliniana, Mx. Ancaster.
Mitella diphylla. L.
" nuda, L.
Tiarella cordifolia, L.
* Chrysosplenium Americanum, Schwein. Ancaster.

CRASSULACEÆ.

Penthorum sedoides, L.
Sedum ternatum, Mx. The Mountain.
" Telephium, L.

HAMAMELACEÆ.

Hamamelis Virginica, L.

HALORAGEÆ.

Myriophyllum spicatum, L.
* " verticillatum, L.
* " heterophyllum, Mx. Waterdown Creek.

ONAGRACEÆ.

Circæa Lutetiana, L.
" Alpina, L.
Epilobium angustifolium, L.

ONAGRACEÆ—*Continued.*

Epilobium coloratum, Muhl.
Œnothera biennis, L., var. grandiflora.
" biennis, L., var. muricata.
* " pumila, L. Land's Inlet.

LYTHRACEÆ.

Nesaea verticillata, H. B. K.

CUCURBITACEÆ.

* Sicyos angulatus, L.
Echinocystis lobata, Torr. and Gray. In a thicket near Waterdown Creek, and apparently indigenous.

UMBELLIFERÆ.

* Hydrocotyle Americana, L. Ancaster.
Sanicula Canadensis, L.
" Marilandica, L.
Heracleum lanatum, Mx.
Pastinaca sativa, L.
Archangelica atropurpurea, Hoffm.
Conioselinum Canadense, Torr. and Gray.
* Thaspium aureum, Nutt. Prince's Island.
Zizia integerrima, DC.
Cicuta maculata, L.
" bulbifera, L.
Sium lineare, Mx.
Cryptotænia Canadensis, DC.
Osmorrhiza longistylis, DC.
" brevistylis, DC.
Carum carui, L.

ARALIACEÆ.

Aralia racemosa, L.
" nudicaulis, L.
" quinquefolia, Gray.
" trifolia, Gray.

CORNACEÆ.

Cornus Canadensis, L.
" florida, L.
" circinata, L'Her.
" stolonifera, Mx.
" paniculata, L'Her.
" alternifolia, L.

CAPRIFOLIACEÆ.

* Linnæa borealis, Gronov. Lake Medad.
Symphoricarpus racemosus, Mx.
* Symphoricarpus vulgaris, Mx.
* Lonicera flava, Sims.
" parviflora, Lam.
" hirsuta, Eaton.
" ciliata, Muhl.
Lonicera Tartarica, L. Mountain side, west of Queen Street.

CAPRIFOLIACEÆ—*Continued.*

Diervilla trifida, Moench.
Triosteum perfoliatum, L.
Sambucus Canadensis, L.
" pubens, Mx.
* **Viburnum** nudum, L., var. cassinoides. Millgrove.
" pubescens, Pursh.
" acerifolium, L.
" Opulus, L. Also at Fullarton.

RUBIACEÆ.

Galium Aparine, L.
" asprellum, Mx.
" trifidum, L.
" triflorum, Mx.
" boreale, L.
" verum, L
Cephalanthus occidentalis, L.
Mitchella repens, L.

DIPSACEÆ.

Dipsacus silvestris, Mill.

COMPOSITÆ.

Liatris cylindracea, Mx. Railway cutting in Burlington Heights. Also at the Humber.
Eupatorium purpureum, L.
" perfoliatum, L.
" ageratoides, L.
Aster corymbosus, Ait.
" macrophyllus, L.
" lævis, L., var. lævigatus, Willd.
" lævis, L., var. cyaneus, Hoffm.
" azureus, Lindley.
" undulatus, L.
" cordifolius, L.
" sagittifolius, Willd.
" multiflorus, Ait.
" Tradescanti, L.
" miser, L.
" simplex, Willd.
" tenuifolius L. Also at Port Rowan.
" carneus, Nees.
" puniceus, L.
" Novæ Angliæ.
" graminifolius, Pursh.
" ptarmicoides, Torr. and Gray.
Erigeron Canadense, L.
Erigeron bellidifolium, L.
" Philadelphicum, L.
" annuum, Pers.
" strigosum, Muhl.
Diplopappus umbellatus, Torr. and Gray.
Solidago squarrosa, Muhl.
" bicolor L.

COMPOSITÆ—*Continued.*

Solidago bicolor L. var. concolor.
" latifolia, L.
" caesia, L.
* " stricta, Ait.
" speciosa, Nutt.
" Virga-aurea. L., var. humilis.
" rigida, L.
" patula, Muhl.
" arguta, Ait., var. juncea.
" " " " scabrella.
" Muhlenbergii, Torr. and Gray.
" altissima, L.
" ulmifolia, Muhl.
" nemoralis, Ait.
" Canadensis, L.
" " " var. scabra.
" serotina, Ait.
" gigantea, Ait.
" lanceolata, L.
Inula Helenium, L
Polymnia Canadensis, L.
" " var. discoidea.
Ambrosia artemisiæfolia, L.
Xanthium strumarium, L., var. echinatum.
Xanthium spinosum, L.
Rudbeckia laciniata, L.
" hirta, L.
Helianthus strumosus, L.
" divaricatus, L.
* " divaricatus, L., var. with leaves whorled in threes. Prince's Island.
" decapetalus, L.
Bidens frondosa, L.
" connata, Muhl.
" " var. petiolata.
" cernua, L.
" chrysanthemoides, Mx.
" Beckii, Torr.
* Helenium autumnale, L.
Maruta cotula, DC.
Achillea millefolium. L.
Leucanthemum vulgare, Lam.
Tanacetum vulgare, L.
Artemisia Canadensis, Mx.
Gnaphalium decurrens, Ives. Also at Fullarton.
* Gnaphalium polycephalum, Mx.
" uliginosum, L.
Antennaria margaritacea, R. Brown.
" plantaginifolia, Hook.
Erechthites hieracifolia, Raf.
Senecio vulgaris, L.
* Senecio palustris, Hook. Roadside, Burlington.

COMPOSITÆ—*Continued.*

Cirsium lanceolatum, Scop.
" discolor, Spreng.
" arvense, Scop.
Onopordon Acanthium, L.
Lappa officinalis, Allioni.
* Lampsana communis, L.
Leontodon autumnale, L.
Hieracium Canadensis, Mx.
" scabrum, Mx.
* " venosum, L Ancaster.
" paniculatum, L.
Nabalus albus, Hook.
" " var. serpentarius.
" altissimus, Hook.
* Nabalus Fraseri, DC., var. integrifolius. Prince's Island.
Taraxacum Dens-leonis, Desf.
Lactuca sativa, L. Apparently spontaneous below Mountain View Hotel.
" Canadensis, L.
Mulgedium leucophæum, DC.
Sonchus oleraceus, L
" asper, Vill.
" arvensis, L.

LOBELIACEÆ.

* Lobelia cardinalis, L. Near Waterdown.
" syphilitica, L.
" inflata, L.
" spicata, Lam.

CAMPANULACEÆ.

Campanula rotundifolia, L.
" aparinoides, Pursh.
" Americana, L.
Specularia perfoliata, DC.

ERICACEÆ.

Gaylussacia resinosa, Torr. and Gray.
Vaccinium vacillans, Solander.
* Chiogenes hispidula, Torr. and Gray. Millgrove.
Gaultheria procumbens, L.
* Cassandra calyculata, Don. Millgrove.
Ledum latifolium, Ait. Lake Medad.
Pyrola rotundifolia, L., var. asarifolia.
" " " uliginosa.
" elliptica, Nutt.
" secunda, L.
* Moneses uniflora, L. Lake Medad.
Chimaphila umbellata, Nutt.
* Pterospora Andromedea, Nutt. Wood on Cline's Farm.
Monotropa uniflora, L.

AQUIFOLIACEÆ.

Ilex verticillata, Gray.
Nemopanthes Canadensis, DC. Millgrove Marsh.

PLANTAGINACEÆ.

Plantago major, L.
" Kamtschatica, Cham. Also at Toronto and London.
" lanceolata, L.

PRIMULACEÆ.

Trientalis Americana, Pursh.
Lysimachia thyrsiflora, L.
* " stricta, Ait. East Flamboro'.
" quadrifolia, Ait.
" ciliata, L.
* Anagallis arvensis, L.
Samolus Valerandi, L., var. Americanus, Gray.

LENTIBULACEÆ.

Utricularia vulgaris, L.
" intermedia, Hayne.

OROBANCHACEÆ.

Epiphegus Virginiana, Bart.
* Conopholis Americana, Wallroth. Wood behind Cline's Mill.
Aphyllon uniflorum, Torr. and Gray.

SCROPHULARIACEÆ.

Verbascum Thapsus, L.
" Blattaria, L.
Linaria vulgaris, Mill.
Scrophularia nodosa, L.
Chelone glabra, L.
Pentstemon pubescens, Solander.
Mimulus ringens, L.
* Gratiola Virginiana L. Hall's Corners.
Ilysanthes gratioloides, Benth.
Veronica Anagallis, L.
" Americana, Schweinitz.
* " scutellata, L. Millgrove.
" officinalis, L.
" serpyllifolia, L.
" peregrina, L.
" arvensis, L Also at Fullarton.
* " triphyllos.
* Gerardia purpurea, L. Waterdown Creek.
* " tenuifolia, Vahl. Prince's Island.
" flava, L.
Gerardia quercifolia, Pursh.
" pedicularia, L.
Castilleia coccinea, Spreng.
Pedicularis Canadensis, L.
Melampyrum Americanum, Mx.

VERBENACEÆ.

Verbena hastata, L.
" urticifolia, L.
Phryma Leptostachya, L.

LABIATÆ.

Teucrium Canadense, L.
Mentha viridis, L.
" piperita, L.
" Canadensis, L.
Lycopus Virginicus, L.
" Europæus, L. var. sinuatus.
* Pycnanthemum incanum, Mx. Oaklands.
Calamintha Clinopodium, Benth. Red Creek.
Satureia hortensis, L. Burlington Heights.
Hedeoma pulegioides, Pers.
Collinsonia Canadensis, L.
Monarda didyma, L. West of Capt. Nichols's Farm.
" fistulosa, L.
Lophanthus nepetoides, Benth. Waterdown Creek.
Nepeta cataria, L.
Brunella vulgaris, L.
Scutellaria galericulata, L.
" lateriflora, L.
* Marrubium vulgare, L.
Galeopsis tetrahit, L.
Stachys palustris, L., var. aspera.
Leonurus cardiaca, L.
* Lamium amplexicaule, L. Wylde's Grounds.
" album, L.

BORRAGINACEÆ.

Echium vulgare, L.
* Symphytum officinale, L. Cumminsville.
Onosmodium Carolinianum, DC. Burlington Beach.
Lithospermum arvense, L.
* " longiflorum, Spreng. Burlington Heights.
Myosotis palustris, Withering.
" " var. laxa.
Echinospermum Lappula, Lehm.
Cynoglossum officinale, L.
" Morisoni, DC.

HYDROPHYLLACEÆ.

Hydrophyllum Virginicum, L.
" Canadensis, L. Chedoke.
" appendiculatum, Mx. Red Creek.

POLEMONIACEÆ.

Phlox divaricata, L.

CONVOLVULACEÆ.

Convolvulus arvensis, L.
Calystegia sepium, R. Br.
* " sepium, R. Br., var. repens Railway Track, East.
* " spithamœa, Pursh. Dundas.
Cuscuta Gronovii, Willd.

SOLANACEÆ.

Solanum dulcamara, L.
" nigrum, L.
Physalis viscosa, L.
Lycium vulgare, Dunal. Near Van Wagner's Farm, Saltfleet.
Hyoscyamus niger, L.
Datura Stramonium, L.
" tatula, L. Burlington Beach.
Nicotiana rustica, L. West Flamboro and Shore of Bay, near G. W. R. Station.

GENTIANACEÆ.

*Halenia deflexa, Grisebach. Ancaster.
Gentiana crinita, Froel.
* " alba, Muhl. Rare.
" Andrewsii, Griseb. Dundas Marsh.
* " acuta, Mx. [Query].
* Menyanthes trifoliata, L. Lake Medad.

APOCYNACEÆ.

Apocynum androsæmifolium, L.
" cannabinum, L.

ASCLEPIADACEÆ.

Asclepias Cornuti, Decaisne.
" phytolaccoides, Pursh.
" incarnata, L.
" tuberosa, L.

OLEACEÆ.

Fraxinus Americana, L.
" sambucifolia, Lam.

ARISTOLOCHIACEÆ.

Asarum Canadense, L.

PHYTOLACCACEÆ.

Phytolacca decandra, L. Stony Creek. Also at Port Rowan.

CHENOPODIACEÆ.

Chenopodium album, L.
" glaucum, L.
" hybridum, L.
" Botrys, L.
" ambrosioides, L.

CHENOPODIACEÆ—*Continued.*

Blitum capitatum, L.
" Bonus Henricus, Reichenbach.
Atriplex patula, L. var. littoralis.
" " " " hastata.

AMARANTACEÆ.

Amarantus hypochondriacus, L.
" paniculatus, L. Also at Guelph.
" retroflexus, L.
" albus, L.

POLYGONACEÆ.

Polygonum Pennsylvanicum, L.
" incarnatum, Ell.
" Persicaria, L
" Hydropiper, L.
" acre, H. B. K.
" hydropiperoides, Mx.
" amphibium, L., var. aquaticum.
" amphibium, L., var. terrestre.
" Virginianum, L. Red Creek.
" aviculare, L.
" " " var. erectum.
" arifolium, L.
" sagittatum, L.
" Convolvulus, L.
" dumetorum, L.
Fagopyrum esculentum, Moench.
Rumex orbiculatus, Gray.
" verticillatus, L.
" crispus, L.
" obtusifolius, L. East of City.
" acetosella, L.

CERATOPHYLLACEÆ

Ceratophyllum demersum, L.

LAURACEÆ.

Sassafras officinale, Nees.
* Lindera Benzoin, Meisner. The Dell Ancaster.

THYMELEACEÆ.

Dirca palustris, L. Carlisle.

ELÆAGNACEÆ.

Shepherdia Canadensis, Nutt.

SANTALACEÆ.

Comandra umbellata, Nutt.

EUPHORBIACEÆ.

Euphorbia polygonifolia, L.
" maculata, L.
" hypericifolia, L. Waterdown.

EUPHORBIACEÆ—*Continued.*

* Euphorbia platyphylla, L. The beach near Stony Creek.
* " obtusata, Pursh. [Query].
" Helioscopia, L.
" cyparissias, L.
" Peplus, L.
Acalypha Virginica, L.

URTICACEÆ.

Ulmus fulva, Mx.
" Americana, L.
Urtica gracilis, Ait.
Laportea Canadensis, Gaudichaud.
Pilea pumila.
Boehmeria cylindrica, Willd.
Cannabis sativa, L
Humulus Lupulus, L. Red Creek.

PLATANACEÆ.

Platanus occidentalis, L.

JUGLANDACEÆ.

Juglans cinerea, L.
" nigra, L.
Carya alba, Nutt.
" porcina, Nutt.
" amara, Nutt.

CUPULIFERÆ.

Quercus alba, L.
" macrocarpa, Mx. E. Flamborough and Burlington Beach.
" Prinus, L., var. acuminata, Mx.
" coccinea, Wang., var. tinctoria, Gray.
" rubra, L.
Castanea vesca, L., var. Americana, Mx.
Fagus ferruginea, Ait.
Corylus rostrata, Ait.
Ostrya Virginica, Willd.
Carpinus Americana, Mx.

BETULACEÆ.

Betula lenta, L.
" lutea, Mx.
" papyracea, Ait.
Alnus incana, Willd.

SALICACEÆ.

* Salix tristis, Ait. Rocks near Ancaster.
" humilis, Marshall.
" discolor, Muhl.
" cordata, Muhl., var. myricoides, Gray.
" livida, Wahl., var. occidentalis, Gray.

SALICACEÆ—*Continued.*

Salix lucida, Muhl.
" nigra, Marsh.
" longifolia, Muhl. Burlington Beach.
Populus tremuloides, Mx.
" grandidentata, Mx.
" balsamifera, L.

CONIFERÆ.

Pinus strobus, L.
Abies nigra, Poir. Millgrove.
" alba, Mx. Lake Medad.
" Canadensis, Mx.
" balsamea, Marshall.
Larix Americana, Mx.
Thuja occidentalis, L.
Juniperus Virgiania, L.
" communis, L.
Taxus baccata, L., var. Canadensis, Gray.

ARACEÆ.

Arisæma triphyllum, Torr.
Calla palustris, L.
Symplocarpus fœtidus, Salish.
Acorus Calamus, L.

LEMNACEÆ.

Lemna minor, L.
" polyrrhiza, L.
" trisulca, L.
Wolffia Columbiana, Karsten.
" Brasiliensis, Weddell.

TYPHACEÆ.

Typha latifolia, L.
Sparganium eurycarpum, Engelm.
" simplex, Hudson, var. angustifolium, Gray.

NAIADACEÆ.

Potamogeton natans, L.
" amplifolius, Tuckerm.
" lucens, L., var. minor.
" perfoliatus, L.
" compressus, L.
" pauciflorus, Pursh.
" pectinatus, L.

ALISMACEÆ.

Alisma plantago, L., var. Americanum, Gray.
Sagittaria variabilis, Engelm.

HYDROCHARIDACEÆ.

Anacharis Canadensis, Planchon.
Vallisneria spiralis, L.

ORCHIDACEÆ.

Orchis spectabilis, L.

ORCHIDACEÆ—*Continued.*

* **Habenaria** tridentata, Lindl. Millgrove.
* " virescens, Spreng. Prince's Island.
* " viridis, R. Br., var. bracteata, Reichenbach. Mountain at head of Queen Street.
* " hyperborea, R. Br. Sulphur Spring.
" Hookeri, Torr.
* " orbiculata, Torr.
* " leucophæa, Gray. Millgrove.
* " psychodes, Gray. Millgrove.
* " fimbriata, R. Br. Land's Farm.
Goodyera pubescens, R. Br.
* **Spiranthes** cernua, Richardson. The Dell, Ancaster.
* **Pogonia** ophioglossoides, Nutt. Millgrove.
* **Calypso** borealis, Salisb. Lake Medad.
* **Corallorhiza** innata, R. Br. Prince's Island.
" odontorhiza, Nutt.
" multiflora, Nutt.
Cypripedium parviflorum, Salisb.
" pubescens, Willd.
* " spectabile, Swartz. Lake Medad.
* " acaule, Ait. Millgrove.

AMARYLLIDACEÆ.

* **Hypoxys** erecta, L. Prince's Island.

IRIDACEÆ.

Iris versicolor, L.
Sisyrinchium Bermudiana, L., var. anceps, Gray.

DIORCOREACEÆ.

Dioscorea villosa, L. Near Dundas Marsh.

SMILACEÆ.

Smilax hispida, Muhl.
" herbacea, L.

LILIACEÆ.

Trillium grandiflorum, Salisb.
" erectum, L.
" erectum, L., var. album, Pursh.

LILIACEÆ—*Continued.*

Medeola Virginica, L.
Uvularia grandiflora, Smith.
Prosartes lanuginosa, Don.
Streptopus roseus, Mx.
Clintonia borealis, Raf.
Smilacina racemosa, Desf.
" stellata, Desf.
" trifolia, Desf.
" bifolia, Ker.
Polygonatum biflorum, Ell.
Lilium Philadelphicum, L.
* Lilium Canadense, L. Ancaster.
" superbum, L.
Erythronium Americanum, Smith.
Allium tricoccum, Ait.
Asparagus officinalis, L. Burlington Beach.

JUNCACEÆ.

Luzula pilosa, Willd.
" campestris, DC.
Juncus effusus, L.
" bufonius, L.
" tenuis, Willd.
" Alpinus, Villars, var. insignis, Fries.
" acuminatus, Mx.
" nodosus, L.
" nodosus, L., var. megacephalus, Torr.

PONTEDERIACEÆ.

Pontederia cordata L.
Schollera graminea, Willd.

CYPERACEÆ.

Cyperus diandrus, Torr.
" strigosus, L.
" filiculmis, Vahl.
Eleocharis obtusa, Schultes.
" palustris, R. Br.
" acicularis, R. Br.
* Scirpus pungens, Vahl.
" validus, Vahl.
" fluviatilis, Gray.
" atrovirens, Muhl.
" Eriophorum, Mx., var. cyperinus.
Eriophorum Virginicum, L. Millgrove.
* " polystachyon, L. The Dell, Ancaster.
Carex polytrichoides, Muhl.
" bromoides, Schk.
" teretiuscula, Good.
" vulpinoides, Mx.

CYPERACEÆ—*Continued.*

Carex stipata, Muhl.
" sparganioides, Muhl.
" cephalophora, Muhl.
" rosea, Schk.
" tenella, Schk.
" trisperma, Dew.
" stellulata, L., var. scirpoides.
" scoparia, Schk.
" lagopodioides, Schk.
" cristata, Schw.
" straminea, Schk., var. tenera, Dew.
" stricta, Lam.
" crinita, Lam.
" aurea, Nutt.
" gracillima, Schw.
" platyphylla, Carey.
" digitalis, Willd.
" retrocurva, Dew.
" laxiflora, Lam.
" " " var. blanda.
" " " " plantaginea, Booth.
" " " var. latifolia.
" pedunculata, Muhl.
" Novæ Angliæ, Schw.
" Emmonsii, Dew.
" Pennsylvanica, Lam.
" varia, Muhl.
" scabrata, Schw.
" riparia, Curtis.
" comosa, Booth.
" hystricina, Willd.
" tentaculata, Muhl.
" intumescens, Rudge.
" lupulina, Muhl.
" Schweinitzii, Dew.
" Tuckermani, Boott.
" retrorsa, Schw.

GRAMINEÆ.

Leersia Virginica, Willd.
" oryzoides, Swartz.
Zizania aquatica, L.
Alopecurus aristulatus, Mx.
Phleum pratense, L.
Vilfa aspera, Beauv. Burlington Beach.
Vilfa vaginæflora, Torr.
Sporobolus cryptandrus, Gray.
Agrostis scabra, Willd.
" perennans, Tuckerm.
" vulgaris, With.
" alba, L.
Muhlenbergia Mexicana, Trin.
* " diffusa, Schreber.

GRAMINEÆ—*Continued.*

Muhlenbergia glomerata, Trin.
" silvatica, Torr. & Gray.
Cinna arundinacea, L.
Brachyelytrum aristatum, Beauv.
Calamagrostis Canadensis, Beauv.
" confinis, Nutt.
Oryzopsis asperifolia, Mx.
" melanocarpa, Muhl.
* Eleusine Indica, Gærtn.
Dactylis glomerata, L.
Eatonia Pennsylvanica, Gray.
Glyceria Canadensis, Trin.
* " elongata, Trin. Binbrook.
" nervata, Trin.
" pallida, Trin.
" aquatica, Smith.
" fluitans, R. Br.
Poa annua, L.
" compressa, L.
" caesia, Smith.
" serotina, Ehrhart.
" pratensis, L.
" debilis, Torr.
Eragrostis poæoides, Beauv.
* Festuca tenella, Willd.
" ovina, L.
" elatior, L., var. pratensis, Gray.
" nutans, Willd.
Bromus secalinus, L.
" Kalmii, Gray.
" ciliatus, L.
Phragmites communis, Trin.
Lolium perenne, L.
Triticum repens, L.
" " " var. nemorale.
" caninum, L.
Elymus Virginicus, L.
" Canadensis, L.
" " " var. glaucifolius.
" striatus, Willd.
Gymnostichum Hystrix, Schreber.
Danthonia spicata, Beauv.
Avena striata, Mx. Lake Medad.
* Aira flexuosa, L.
Holcus lanatus, L.
* Anthoxanthum odoratum, L.
Phalaris arundinacea, L.
" canariensis, L.
Panicum glabrum, Gaudin.
" sanguinale, L.
" capillare, L.
" latifolium, L.
" xanthophysum, Gray.
" dichotomum, L.

GRAMINEÆ—*Continued.*

Panicum depauperatum, Muhl.
" Crus-Galli, L.
" " " var. hispidum, Gray.
Setaria glauca, Beauv.
" verticillata, Beauv.
" viridis, Beauv.
" Italica, Kunth.
Cenchrus tribuloides, L. G. W. Ry., about a mile east of Dundas.
Andropogon furcatus, Muhl.
" scoparius, Mx.
Sorghum nutans, Gray.

EQUISETACEÆ.

Equisetum arvense, L.
" pratense, Ehrhart.
" silvaticum, L.
" limosum, L.
* " palustre, L. Oaklands.
" hiemale, L.
" variegatum, Schleicher.
" scirpoides, Mx.

FILICES.

Polypodium vulgare, L.
Adiantum pedatum, L.
Pteris aquilina, L.
Pellæa atropurpurea, Link. Mountain below Chedoke.
Woodwardia Virginica, Smith.
* Asplenium Trichomanes, L. Lake Medad.
" thelypteroides, Mx.
" Filix-fœmina, Bernh.
Camptosorus rhizophyllus, Link.
Phegopteris hexagonoptera, Fée.
* " Dryopteris, Fée. Sulphur Spring.
Aspidium Thelypteris, Swartz.
" Noveboracense, Willd.
* " spinulosum, Swartz,. var. dilatatum.
" spinulosum, Swartz, var. Boottii.
" spinulosum, Swartz, var. intermedium.
" spinulosum, Swartz, var. dumentorum. Ravine below Chedoke.
" cristatum, Swartz, var. Clintonianum.
" Goldianum, Hook.
" marginale, Swartz.
" acrostichoides, Swartz.

FILICES—*Continued*

Cystopteris bulbifera, Bernh.
" fragilis, Bernh.
Struthiopteris Germanica, Willd.
Onoclea sensibilis, L.
Dicksonia punctilobula, Kunze.
Osmunda regalis. L. Millgrove.
" Claytoniana, L.
" cinnamomea, L.

FILICES—*Continued.*

Botrychium Virginicum, Swartz.
" lunarioides, Swartz.

LYCOPODIACEÆ.

Lycopodium clavatum, L.

HYDROPTERIDES.

Azolla Caroliniana, Willd. Dundas Marsh and Burlington Beach.

NOTES.

Viola striata, Ait. In Professor Macoun's Catalogue of Canadian Plants, this is stated on the authority of the late Judge Logie to be common near Hamilton. I have never found it, and I am sure that it is not common.

Lathyrus venosus, Muhl., occurs at St. Thomas.

Cichorium Intybus, L., has naturalized itself at Port Rowan and Toronto.

Mimulus Jamesii, Torr., is abundant along the stream flowing into Grenadier Pond near the Humber.

Phlox subulata, L. I can confirm, from personal observation, the fact which Mr. Wilkins was, I believe, the first to discover, that this species is indigenous in the County of Norfolk.

Rumex sanguineus, L., occurs at London and Barrie.

Ulmus racemosa, Thomas, occurs at St. Thomas.

Juniperus Sabina, L., *var. procumbens*, Pursh., which I formerly reported as occurring, proves to be J. *Virginiana*, L.

In the discussion which followed, Mr. Geo. E. Shaw, Mr. T. Mackenzie, Mr. Henry Montgomery, Mr. James Bain, jun., and the reader of the paper took part.

Mr. Fred. Phillips read a paper on "The Antiquity of the Negro Race," the object of which was to show that the negro race made its appearance before the white races.

A discussion ensued, in which the President, Mr. John Notman, and Mr. Montgomery took part.

TWELFTH ORDINARY MEETING.

The Twelfth Ordinary Meeting of the Session 1883-'84 was held on Saturday, February 2nd, 1884, Dr. Geo. Kennedy, Third Vice-President, in the chair.

The minutes of last meeting were read and confirmed.

The following list of donations and exchanges received since last meeting was read :—

1. The Financial Reform Almanack for 1884 ; presented by the Cobden Club.

2. Museum of Comparative Zoölogy at Harvard College, Vol. XI., Nos. 5, 6, 7.
3. Proceedings of the American Academy of Arts and Sciences, Vol. XI., pp. 45—210.
4. Journal of the Franklin Institute for February, 1884.
5. Science Record, January 15, 1884.
6. Science, for January 25, 1884.
7. Proceedings of the Academy of Natural Sciences of Philadelphia, Part 2, June to October, 1883.
8. Nye Alcyonider Gorgonider, og Pennatulider, tilhorende Norges Fauna; from the Royal Museum of Bergen. (Norwegian Fauna.)

Prof. G. P. Young then read a paper entitled, "The Real Correspondents of Imaginary Points."

After the reading of the paper, remarks were made upon the subject by Prof. Galbraith and Mr. Alfred Baker.

THIRTEENTH ORDINARY MEETING.

The Thirteenth Ordinary Meeting of the Session 1883-'84 was held on Saturday, February 9th, 1884, the President in the Chair.

The minutes of last meeting were read and confirmed.

The following list of donations and exchanges received since last meeting was read :—

1. Transactions of the New York Academy of Sciences, Vol. II., Nos. 3 to 8. Contents and Title Page, Vol. I.
2. Annals of the New York Academy of Sciences, Nos. 12 and 13, Vol. II.
3. The Canadian Practitioner, for February, 1884.
4. Science, Vol. III., No. 52, for February, 1884.
5. Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils, November, 1883.
6. Bulletin of the Museum of Comparative Zoology at Harvard College, Vol. XI., No. 8.

It was moved and seconded "That the Council be a Committee, with power to add to their number, to arrange for the reception and entertainment of such members of the British Association as may visit Toronto during the month of September."—*Carried.*

Mr. W. H. VanderSmissen then read a paper by the Rev Prof. Campbell of Montreal, on

THE KHITAN LANGUAGES; THE AZTEC AND ITS RELATIONS.

My translation of the Hittite Inscriptions found at Hamath and Jerabis, in Syria, is the only one yet published with an explanation of the process by which it was accomplished. The Rev. Dunbar I Heath has sent me copies of his papers in which the Hamath inscriptions are translated as Chaldee orders for musical services, but no process is hinted at by the learned author. In the discussion which followed the reading of one of these papers, a well-known Semitic scholar remarked, "that so long as no principle was laid down and explained as to the system by which the characters had been transliterated, it would be impossible to express an opinion on the value of the proposed reading." Whatever may be the merits of my translation, it does not make default in this respect. The process is simple and evident. The phonetic values of the Aztec hieroglyphic system are transferred to corresponding hieroglyphic characters in the Hittite inscriptions. Common Hittite symbols are the arm, the leg, the shoe, the house, the eagle, the fish. These are also found as Mexican hieroglyphics. There is nothing to tell us what their phonetic values are in Hittite, because hardly any other remains of the Hittite language have survived. But in Aztec we know that these values are the first syllables of the words they represent. Thus an arm being called *neitl*, gives the phonetic value *ne* for the hieroglyphic representing an arm. A leg being called *meztli*, furnishes *me*. A shoe gives *ca* from *cactli;* a house, also, *ca* from *calli;* an eagle, *qua* from *quauhli;* and a fish, *mi* from *michin*. But the question has been raised, "What possible connection can there be between the Hittites or Khita of ancient Syria and the Aztecs of Mexico?" As well might we ask what connection can there be between Indian Brahmins and Englishmen; between European Osmanli and Siberian Yakuts. Geographical separation in such case, is simply the result of a movement that has been going on from early ages. Men are not plants nor mere animals to be restricted to floral and faunal centres. The student of history, who has followed the Hunnic and Mongolian hordes in their devastating course across two

continents, will not be surprised to find that well-known Iroquois scholar, the Abbé Cuoq, suggesting the relationship of the Iroquois with the wandering and barbarous Alans and Huns. Still less surprise should be experienced when the more cultured Aztecs of Mexico are connected with an ancient Old World civilization. Aztec history does not begin till the 11th century of our era, and even that of the Toltecs, who preceded the Aztecs, and were of the same or of an allied race, goes no farther back than the 8th. The period of their connection with Old World history as a displaced Asiatic people is thus too early to be accounted for by the invasions of the Mongols, but coincides with the eastern movements of the Khitan, who, after centuries of warfare on the borders of Siberia, disappeared from the historian's view in 1123. It is certainly a coincidence that the Aztecs should claim to be of the noble race of the Citin, and that *citli*, the hare, or, in the plural, *citin*, should be the totem or heraldic device of their nation.

Since I wrote the article on the Khitan Languages, in which I traced the Chinese Khitan backwards to central Siberia about the sources of the Yenisei, where, according to Malte Brun, the Tartars called their mounds Li Katei, or the tombs of the Cathayans, I have received from Mr. Vl. Youferoff, of the Imperial Society of Geography at St. Petersburg, copies of the chief inscriptions from that region. These triumphantly confirmed my supposition that the Katei and the Khita or Hittites were the same people, by presenting characters occupying a somewhat intermediate position in form between the Hittite hieroglyphics and the more cursive script of our Mound Builders. The rude representations of animals and other natural objects accompanying some of the inscriptions are precisely of the type furnished by the Davenport Stone. One inscription, which I deciphered and the translation of which is now before the Imperial Society of Géography, relates the victory of Sekata, a Khitan monarch, the Sheketang of the Chinese hostorians, over two revolted princes or chiefs dwelling at Uta or Utasa in Siberia. As in the case of the Syrian Hittite inscriptions, I have translated the Siberian one by means of the Japanese, using the Basque, the Aztec, and other languages of the Khitan family, for confirmation. Whatever foreign influences may have done to modify the physical features, the character, language, religion, and arts of the Japanese, and, in lesser measure, of the Coreans, there can be no doubt that these are

at basis Hittite or Khitan. Already at the commencement of my Hittite studies I had noted the agreement of many characters in the Corean alphabet with those of Hamath and Jerabis on the one hand, and, on the other, with those on our mound tablets. The Rev. John Edwards of Atoka with great kindness procured for me, from a member of the Japanese Imperial Household at Tokio, a work on the ancient writing of the Japanese. One of the forms of writing exhibited in this work and occupying much space is very similar to the Corean, and is undeniably of the same origin. I have not yet had time to investigate the volumes thoroughly, but as they appear to contain samples of ancient alphabets with guesses at their signification rather than complete inscriptions, little progress may be anticipated by means of them. Nevertheless the existence in Japan of a syllabary of so Hittite a type as the Corean in ancient times is confirmatory of the Khitan origin of the Japanese. As for the relations of American civilizations, such as those of the Mexicans, Muyscas, and Peruvians, with that of Japan, I need only refer to the writings of so accurate and judicious an observer as Humboldt.

Returning to the Hittites of Syria, who figure so largely in the victorious annals of the Egyptian Pharaohs and Assyrian kings, and whose empire came to an end towards the close of the 8th century B.C., we find that, although apart from my own conclusions no definite opinion has been reached regarding their language beyond the mere fact that it was Turanian, guesses have been made by scholars whose hypotheses even are worthy of consideration. Professor Sayce believes the Hittite language to have been akin to that furnished by the ancient Vannic inscriptions of Armenia. The Vannic language, according to Lenormant, belongs to the Alarodian family, of which the best known living example is the Georgian of the Caucasus. Now it is the Caucasus that I have made the starting point of Hittite migration, which terminated at Biscay in the west, and in the east, reaching the utmost bounds of Northern Asia, overflowed into America. Not only the Georgians, I unhesitatingly assert, but most of the other Caucasian families, the Circassians, Lesghians, and Mizjeji at least, should be classed as Alarodians, or better still as Khitan. So far I have found no evidence from ancient Caucasian inscriptions, though such I believe have been discovered; but an evidence as conclusive is furnished by the languages of the Caucasian families I have named as compared with those which are presum-

ably of Hittite origin in the Old World and in the New. In the remainder of this paper, I propose chiefly to set forth the relations of the Aztec language, by means of which I transliterated the Hittite inscriptions, with the Caucasian tongues, which of all Khitan forms of speech are in closest geographical propinquity to the ancient habitat of the Hittite nation. Before doing so I may set forth the principal members of the Khitan family at the present day.

THE KHITAN FAMILY.

1. Old World Division.

Basque.
Caucasian = Georgian, Lesghian, Circassian, Mizjeji.
Siberian = Yeniseian, Yukahirian, Koriak, Tchuktchi, Kamtchadale.
Japanese = Japanese, LooChoo, Aino, Corean.

2. American Division.

Daootah.
Huron-Iroquois including Cherokee.
Choctaw-Muskogee including Natchez.
Pawnee including Ricaree and Caddo.
Paduca = Shoshonese, Comanche, Ute, &c.
Yuma = Yuma, Cuchan, Maricopa.
Pueblos = Zuni, Tequa, &c.
Sonora = Opata, Cora, Tarahumara, &c.
Aztec including Niquirian.
Lenca = Guajiquiro, Opatoro, Intibuca.
Chibcha or Muysca.
Peruvian = Quichua, Aymara, Cayubaba, Sapibocono, Atacameno, &c.
Chileno = Araucanian, Patagonian, Fuegian, &c.

The Nahuatl, or language of the Aztecs, as distinguished from other tribes of diverse speech inhabiting Mexico, has long been a subject of no little difficulty to philologists. It is not that its grammatical construction is peculiar, but because its vocabulary exhibits combinations of letters or sounds that have come to be regarded as its almost peculiar property. The most important of these is the sound represented by *tl*, whether it be initial, medial or final. The Aztecs of Nicaragua drop the *tl* altogether or reduce it to *t*; hence some writers have supposed theirs to be the true form of the language, and the literary tongue of Mexico a corruption. Upon this an argument has been founded for the southern origin of the Nahua race. But, as Dr. Buschmann and others have shewn, a mere casual survey of the languages of more northern peoples, the Sonora and Pueblo tribes, and the great Paduca family, reveals the fact that they con-

tain a considerable proportion of Aztec words, and that in them, as in the Nahuatl of Nicaragua, the Aztec *tl* disappears or is converted into *t*, *d*, *k*, *s*, *r* or *l*. Here therefore it is claimed by others is an argument for the northern derivation of the Mexicans.

If we carry forward the work of comparison, having regard to certain laws of phonetic change, we shall find, as I profess to have done, that the vocabulary, and to a large extent the grammar, of the Aztecs are those of all the greater families in point of culture and warlike character of the Northern and Southern Continents. Nor do the Aztec and its related American languages form a family by themselves. They have their counterparts, as I have indicated, in many regions of the Old World. If my classification of these languages be just, there should, among a thousand other subjects of interest, be found some explanation of the great peculiarity of Aztec speech to which I have referred.

The Aztec combination *tl* appears, although to no very great extent, in the Koriak, Tchuktchi, and Kamtchatdale dialects. It has no place in Corean, Japanese, or Aino, and only isolated instances of its use are found in the Yukahirian and Yeniseian languages. Of the four Caucasian tongues which pertain to the Khitan family, two, the Georgian, and Mizjeji, are almost as destitute of such a sound as the Corean and Japanese ; while the Circassian and Lesghian vocabularies, by their frequent employment of *tl*, reproduce in great measure the characteristic feature of the Nahuatl. It is altogether wanting in the Basque, and is a combination foreign to the genius of that language. Yet there is no simpler task in comparative philology than to show the radical unity of the Basque and Lesghian forms of speech. Such a comparison, as well as one of the Lesghian dialects among themselves and with the other Caucasian languages, will enable us to decide whether the *tl* of the Lesghian and Circassian forms part of an original phonetic system, or is an expedient, naturally adopted by speakers whose relaxed vocal organs made some other sound difficult or impossible, to stave off the process of phonetic decay by substituting for such sound the nearest equivalent of which they were capable.

In order first of all to exhibit the common origin of the Basque and the Lesghian, I submit the following comparison of forms, the relations of which are apparent to the most casual observer. The Lesghian vocabulary is that of Klaproth, contained in his Asia Poly-

glotta; the Basque is derived from the dictionaries of Van Eys and Lecluse. It will be observed that the Lesghian almost invariably differs from the Basque :—

1. In substituting *m* for initial *b*.
2. In dispensing with initial vowels; or, when they cannot be dispensed with, in prefixing to them *b* or *p*, *t* or *d*.
3. In generally rendering the Basque aspirate, together with *ch* and *g*, by the correspondingly harder forms *g*, *k* and *q*.
4. In occasionally adding final *l* or *r*.

(The last named letters *l* and *r* are interchangeable in the Khitan as they are in all other families of speech.)

COMPARISON OF BASQUE AND LESGHIAN.

	English.	Basque.	Lesghian.
Rule 1.	beard	bizar	mussur, muzul
	head	buru	mier, maar
	nail	behatz	maats
	back	bizkhar	machol, michal
	to-morrow	bihar	michar (Georgian)
Rule 2, *a*.	skin	achala	quli
	hand	ahurra	kuer
	river	uharre	chyare, uor
	thunder	ehurzuria, curciria	gurgur
	hair	ileak	ras
	cold	otzo	zoto
	no	ez	zu
	left hand	ezquerra, ezker	kuzal, kisil
	milk	eznea	sink
	star	izarra	suri
	day	eguna	kini
Rule 2, *b*.	deer	oreina	burni
	clothes	aldar	paltar
	child	aurra	durrha
	stone	arri, harri	tsheru, gul
Rule 3.	great	handi	kundi
	house	eche	akko
	hail	harri	goro
	smoke	gue	kui
	tooth	hortz	kertschi
	leaf	orri	kere
	finger	erhi	kilish
Rule 4.	rain	uria	kural
	son	seme	chimir
	great	zabala	chvallal

The following, though generally agreeing, present same exceptions to the above rules.

ENGLISH.	BASQUE.	LESGHIAN.
heaven	ceru	ser
bird	chori	zur
red	gori, gorri	hiri
blue, green	urdin	crdj'n
death	heriotze	haratz
old	agure, zar, zahar	herau, etshru
throat	cinzur	seker
white	churia, zuria	tchalasa
wood	zura	zul
leg	aztal	uttur
tree	zuhatsa	guet, hueta
fire	su	zo
high	gan	okanne
tongue	mia	mas

A comparison of the Basque with the other Caucasian languages, Georgian, Circassian, and Mizjeji, would display similar relations with some modification of the laws of phonetic change.

If now we ask what the Basque does with the Lesghian *tl*, we shall find that it represents that sound chiefly by the letters *r* and *l*. This equivalency of *tl*, and sometimes of *ntl*, to *r* and *l* also appears in comparing the Lesghian dialects among themselves or with other Caucasian languages.

COMPARISON OF LESGHIAN FORMS IN *tl* WITH OTHER CAUCASIAN AND BASQUE FORMS.

ENGLISH.	LESGHIAN.	OTHER FORMS.
hair	tlozi	ras, *Lesghian.*
bone	tlusa	rekka "
wood	thludi	redu-kazu "
tomorrow	shishatla	shile "
night	retlo	rahle "
sheep	betl	bura "
maize	zoroto-roodl	tzozal-lora "
goat	antle	arle
six	antlko	ureekul
nail	matl	mare, *Mizjeji*
low	tlukur	lochun "
eight	bitlno	bar, barl "
sun	mitli	malch
"	" beri, *Lesghian.*	marra, *Circassian.*
flesh	ytl	glli "
forehead	tlokva	illech "
easy	intlaugu	illesu "
"	"	errecha, *Basque.*
loins	tlono	errainac "
water	htli	ur "
butter	yetl	guri "
hair	tlozi	ileac "
earth	ratl	lurra, laur "

The following represent the exceptions to the rule both in form and in numerical proportion:—

English.	Lesghian.	Other Forms.
yellow	tlela	dula, *Lesghian.*
day	tlyal	thyal, tchzal "
horn	tlar	adar, *Basque.*
knee	tlon	belaun "

From the preceding examples it appears that the Lesghian sounds represented by *tl*, *thl*, *ntl*, are the equivalents of *r* and *l* generally, and sometimes of *d* or *t*. The latter exception probably finds its explanation in Basque, for in the dialects of that language an occasional permutation of *r* and *l* into *t* and *d* takes place. Thus *ideki* to take away, becomes *ireki*, and *iduzki* the sun, becomes *iruzki*, while *elur* snow, sometimes assumes the form *edur*, and *belar* grass, that of *bedar*. The last exception cited, that in which the Lesghian *tlon* is compared with the Basque *belaun*. is really no exception, for *elaun* is the true representation of *tlon*, the initial *b* being prosthetic to the root, as is frequently the case in Basque. Among many examples that might be given, I may simply cite *belar* the ear, as compared with the Mizjeji *lerk*.

Turning now to the Aztec, on the supposition that it is related to the Basque and Caucasian languages, we naturally expect to find on comparison a coincidence of roots and even of words following upon the recognition of *tl* and *ntl* as the equivalents of *r* and *l* in these forms of speech. The fact that the Aztec alphabet is deficient in the letter *r* favours such an expectation. But our comparison must be made with due caution. Any one who has examined a Mexican dictionary, such as that of Molina, must have been struck with the remarkable preponderance of words commencing with the letter *t* over those beginning with any other letter of the alphabet. These words comprise considerably more than one third of the whole lexicon. A certain explanation of this is found in the fact that the two particles *te* and *tla* possess, the former an indefinite personal, and the latter a substantive, signification, and thus enter largely into the structure of compound words. Whatever its grammatical value in Aztec, however, it appears, on comparing the Aztec vocabulary with its related forms of speech, that initial *t* or *te*, which leaving *tl* out of account still occupies one fifth of the lexicon, is frequently prosthetic to the root.

The following are some of the chief laws of phonetic change derived

from a comparison of the Aztec and Lesghian languages. These may be found operating to almost as great an extent in the Lesghian dialects among themselves :—

1. The Aźtec combinations *tl*, *ntl*, are either rendered in Lesghian by the same sounds, or by *r* or *l*. In some cases in which phonetic decay has set in, the Aztec *tl* is either omitted or represented by a dental. The Lesghian occasionally renders the Aztec *l* and *ll* by *tl*.
2. The interchange of *p* and *m*, which appeared in comparing the Basque and the Lesghian, for the Aztec is deficient in the sound of *b*, characterizes a comparison of the Aztec with the Caucasian languages.
3. A similar interchange of *n* and *l*, or the ordinary equivalents of l, such as marked the Iroquois in comparison with the Basque, occasionally characterizes the relations of the Aztec and Caucasian tongues.
4. The Lesghian, as already indicated, persists in the rejection of initial vowels, and the same is generally true of reduplications and medial aspirates.
5. As in many Aztec words initial *t* forms no part of the root, but is a prosthetic particle, it finds no place in such cases in the corresponding Lesghian term.
6. The Lesghian occasionally strengthens a word by the insertion of medial *r* before a guttural, for which of course there can be no provision in Aztec.

I have not thought it desirable to burden this paper with laws relating to other changes, as the relation of the compared words will be sufficiently apparent; but, for the purpose of illustration, I have added corresponding terms from other Khitan languages exemplifying the rules set forth.

COMPARISON OF AZTEC AND LESGHIAN FORMS.

English.	Aztec.	Phonetic Change.	Lesghian.	Illustrations.
water	atl	ar al	htli	ur, *Basque*
low	tlatzintli	latzili, latziri	tlukur	liuchtliu, *Koriak*
day	tlacatli	lacali, lacari	tlyal, djekul	allochal, teluchtat, *Koriak*
knee	tlanquaitl	lancail, lancair	tlon	zangar, *Basque* cconcor, *Quichua*
deer	mazatl	mazal, mazar	mitli	mool, *Yuma*
earth	tlalli	ralli, larri	ratl	lurra, *Basque*
night	tlalli	" "	retlo, rahle	neillhe, *Choctaw*
yesterday	yalhua	alhua	hutl	hooriz, *Dacotah*
ice	cetl	cel, cer	zer, zar	kori, *Japanese*
wind	ehecatl	ehecal, ehecar	churi	gygalkei, *Koriak*
sheep	ichcatl	ichcal, ichcar	kir	achuri, *Basque* ccaora, *Aymara*

English.	Atzec	Phonetic Change.	Lesghian.	Illustrations.
mud	zoquitl	zokil, zokir	zchur	chulu, *Corean*
stone	tetl	tel, ter	tsheru	tol "
dust	teuhtli	teuhli, teuhri	chur	turo, *Quichua*
grass	quilitl	kilil, kirir	cher, gulu	kyrau, *Yeniseian*
star	citlalli	cilalli, cirarri	suri	zirari, *Aino*
hair	tzontli	tzoli, tzori	tshara	thorok, *Corean*
skin	cuatl	cual, cuar	quli	ccara, *Quichua*
eye	ixtli	ishli, ishri	chuli	okahra, *Iroquois*
wood	quauitl	kauil, kauir	zul	kullu, *Quichna*
"	"	kauit	guet, hueta	zuhaitz, *Basque*
foot	icxitl	icshil, icshir	kash	ochsita, *Iroquois*
year	xiuitl	shiuil, shiuir	thahel	osera, "
god	teotl	teol, teor	saal, zalla	chail, koil, *Yukahiri*
clothes	tlatqtl	ratkl, latkr	paltar, retelkum	aldarri, aldagarri, *Basque*
cold	cecuiztli	cecuizli, cecuizri	chuatzala	hutseelo, xetchur, *Yuma*
mountain	tepetl	tepel, teper	dubura	neit-tippel, *Koriak*
moon	metztli	metzli, metzri	moots, bars	muarr, *Shoshonese*
leg	metztli	" "	mahe	onitsa, *Iroquois*
hand	maitl	mail, mair	ku-mur	masseer, *Shoshonese*
honey	necutli	neculi, necuri	nutzi, nuzo	miski, *Quichua*
				mitzi, *Japanese*
bread	tlaxcalli	lashcalli, rashcalli	zulha	lagul, *Yukahiri*
				rajali, *Yeniseian*
copper	tepuztli	tepuzli, tepuzri	dupsi	tup, thep, *Yeniseian*
				tetiopulgun, *Kamtchatdale*
mouth	camatl	camal, camar	sumun, moli	simi, *Quichua*
				homal-galgen, *Koriak*
belly	xillantli	shillal, shillar	siarad	kolid, *Kamtchatdale*
feather	yhuitl	ywil, ywir	bel, pala	puru, *Quichua*
rain	quiahuitl	kiavil, kiavir	gvaral	kutil-kishen, *Koriak*
woman	cihuatl	cival, civar	tshaba	sipi, *Corean*
				sungwal, *Shoshonese*
bird	to-totl	tol, tor	adjari, zur	tori, *Japanese*
name	to-caitl	cail, cair	zyer, zar	chareigtsh, *Kamtchatdale*
				teguala, *Sonora*
beard	te-nchalli	nchalli, ncharri	muzul, mussur	hannockquell, *Shoshonese*
river	at-oyatl	oyal, oyar	uor, chyare	hahuiri, *Aymara*
throat	t-uzquitl	uzkil, uzkir	seker	eztarri, *Basque*
back	to-puztli	puzli, puzri	machol	bizkhar, "
				kaptcher, *Koriak*
sun	to-natiuh	natiuh	mitzi	nitchi, *Japanese*
				inti, *Quichua*
evening	te-otlac	olak, orak	sarrach, *Mizjeji*	sonrek, *Iroquois*
snow	cepayauitl	payauil, payauir	marchala	pukoelli, *Yukahiri*
				pagolka, *Koriak*
man	maceualli	maceualli	murgul	birkhjarjat, *Yeniseian*
				mailik, *Pujuni*
small	tlocoton, tzocoton	locoton, tzocoton	chitina	cikadang, *Dakotah*
				iskitini, *Choctaw*
sand	xalli	shalli, sharri	keru	challa, *Aymara*
shoulders	acolli	acolli, acorri	hiro	callachi, "
son	tepil-tzin	tepil, tepir	timir, chimir	comerse, *Yuma*
				tiperic, *Sonora*
woman, wife	tenamic	tenamic	ganabi	kanafe, *Corean*
fish	michin	michin	migul, besuro	mughat, pughutsi, *Shoshonese*
to-day	axcan	ashcan	djekul	hichuru, *Aymara*
				tachan, *Mizjeji*
give	maca	maca	beckish	eman, emak, *Basque*
stone	topecat	topecat	teb	tipi, *Shoshonese*
black	caputztic	caputztic	kaba	shupitkat, *Dacotah*
hard	tepitztic	tepitztic	debchase	kibichii, *Japanese*
old	veue	veue	vochor	vucha, *Araucanian*
				apachi, *Aymara*
green	quiltic	kiltic	sholdisa	sherecat, *Dacotah*
great	yzachi	izachi	zekko	hashka, "
"	yzachipul	izachipul	chvallal	zabal, *Basque*
dog	chichi	chichi	choi	cocochi, *Sonora*
no	amo	amo	anu	ama, *Quichua*
I	ne	ne	na	ni, *Basque*
				na, *Aymara*
than	te	te	duz	zu, *Basque*
				ta, *Aymara*
he	ye, yehua	he, heua	heich	hau, *Basque*
				uca, *Aymara*

The Georgian does not exhibit the Aztec *tl*, but, as it is regarded by Professor Sayce as the living language most likely to represent the speech of the ancient Hittites, a brief comparison of its forms with those of the Aztec may not be out of place. Like the Lesghian it is impatient of initial vowels, and it generally agrees with that language in the laws of phonetic change, adding, however, this peculiarity, the occasional insertion of *v* before *l*. The *v* seems generally to represent *u*, or some similar vowel sound, and is probably such a corruption of the original as appears in the Samivel of Pickwick compared with the orthodox Samuel.

COMPARISON OF AZTEC AND GEORGIAN FORMS.

English.	Aztec.	Phonetic Change.	Georgian.	Illustrations.
fowl	tototl	totol, totor	dedali	totolin, *Sonora*
red	chichiltic	chichiltic	tziteli	tsatsal, *Kamtchatdale*
blood	eztli	ezli, ezri	sischli	odol, *Basque*
				ehri, *Dacotah*
house	calli	calli	sachli	cari, caliki, *Sonora*
mountain	quautla	kaula, kaura	gora	kkollo, *Aymara*
horn	quaquauitl	kakaul, kakaur	akra	quajra, "
sheep	ichcatl	ichcal, ichcar	tschchuri	ccaora, "
wind	ehecatl	ehecal, ehecar	kari	helcala, *Sonora*
heart	yullotl	yullol, yullor	gulu	gullugu, *Kamtchatdale*
girl	ocuel	ocuel	okurza, kali	okulosoha, *Choctaw*
dog	yzcuintli	izkili, izkiri	dzagli, djogori	schari, *Shoshonese*
nose	yacatl	hacal, hacar	zchviri	surra, *Basque*
				cher, *Pueblos*
hair	tzontli	tzoli, tzori	tzvere (beard)	tsheron, *Kamtchatdale*
moon	metztli	metzli, metzri	mtvare	muarr, *Shoshonese*
silver	teo-quitlatl	kilal, kilar	kvartshili	cilarra, *Basque*
shoulder	te-puztli	puzli, puzri	mchari	buhun, *Lesghian*
tomorrow	muztli	muzli, muzri	michar	mayyokal, *Yuma*
leg	metztli	metzli, metzri	muchli	ametche, "
to kill	miclia	miclia	mokluli	wakerio, enkerio, *Iroquois*
mother	nantli	nali, nari	nana	nourha, *Iroquois*
snow	cepayauitl	cepayauil, cepayauir	tovli	repaliki, *Sonora*
snake	cohuatl	coval, covar	gveli	toeweroe, *Shoshonese*
boy	tepil-tzin	tepil	shvili	tiperic, *Sonora*
lightning	tlapetlani	lapelani	elvai	illappa, *Quichua*
				wilhyap, *Yuma*
leaf	iatla-pallo	iala-pallo, iala-parro	pur-zeli	bil-tlel, *Kamtchatdale*
small	tzocoton	tzocoton	katou	cikadang, *Dacotah*
man	oquichtli	okichli, okichri	ankodj	oonquich, *Iroquois*
			oiakotsh, *Koriak*	aycootch, *Yuma*
			guru, *Aino*	ccari, *Quichua*

The Circassian language abounds in labials, and thus finds its best American representatives among the Dacotah dialects. Nevertheless it presents many words which come under the same general laws in relation to the Aztec that have characterized the Lesghian and Georgian.

COMPARISON OF AZTEC AND CIRCASSIAN FORMS.

ENGLISH.	AZTEC.	PHONETIC CHANGE.	CIRCASSIAN.	ILLUSTRATIONS.
hand	mapipi	mapipi	meppe	nape, *Dacotah*
				mashpa, *Shoshonese*
black	caputztic	caputztic	kvatsha	shupitcat, *Dacotah*
				yupikha, *Shoshonese*
heavy	etic	etic	ondogh	tekay, tekash, *Dacotah*
sister	teicu	teicu	tsheeyakh	itaku, itakisa, "
"				tshakyhetch, *Koriak*
"	tepi, teciuapo	tepi	tabcha, tsheebk	cuhuba, *Muysca*
shoulder	tepuztli	tepuzli	damasha	tapsut, *Aino*
				gepuca, *Muysca*
smoke	poctli	pocli, pocri	bacha	ibusu, *Japanese*
lip	tenxi-palli	tenxi-palli	uku-fari	kuchi-biru, *Japanese*
meat	nacatl	nacal, nacar	mikel	niku, *Japanese*
easy	velchiu-aliztli	velchiu	plese, illesu	raku, "
				errecha, *Basque*
				arrangya, *Yukahiri*
child	acatl	acal, acar	kaala	jacuel, *Yuma*
boy, son	tepil-tzin	tepil	tshvalye, chvalay	akwal-nesuta, *Natches*
man	tlacatl	lacal	tle	kelgola, *Kamtchatdale*
blood	eztli	ezli, ezri	tleh, kleh	odol, *Basque*
				huila, *Aymara*
dog	chichi	chichi	chbah	kahi, *Corean*
no	quixmo	kishmo	ekesima	hetschen, *Lesghian*
summer	xupan	shupan	gapne (spring)	tofah, *Choctaw*

As things which are equal to the same thing are equal to one another, it follows that, by the application of the same law of phonetic change, the vocabulary of the Aztec must coincide with that of the Basque, in spite of the fact that these two tongues have maintained a separate existence for some 2500 or 3000 years. Nothing can more convincingly prove the indestructibility of human speech, not only in mere thought-forms but in the *ipsissima verba*, than a comparison of the two vocabularies.

COMPARISON OF AZTEC AND BASQUE FORMS.

ENGLISH.	AZTEC.	INTERMEDIATE FORMS.	BASQUE.
sheep	ichcatl	kir, *Lesghian*; ccaora, *Aymara*	achuri
nose	yacatl	zchviri, *Georgian*; cher, sodornah, *Pueblos*	sur, sudur
rain	quiavitl	gvaral, *Lesghian*; furi, *Japanese*	euri
star	citlalli	zirari, *Aino*; suri, *Lesghian*	izar
water	atl	htli, *Lesghian*; ul, ur, *Yeniseian*	ur
worm	ocuiloa	kihigir, *Aino*; kuru, *Quichua*	chicharia
bad	aquallotica	whalich, *Yuma*; achali, *Koriak*	char, charto
mountain	quautla	gora, *Georgian*; kar, *Yeniseian*	zerra
stone	tetl	tol, *Corean*; kell, *Yukahiri*	harri
ice	cetl	zer, *Lesghian*; chilen, *Mixjeji*	karroin
fish	atlan	ennen, *Koriak*; olloga, *Yukahiri*	arrain
wood	zalli	zul, *Lesghian*; kullu, *Quichua*	zura
bird	tototl	adjari, zur, *Lesghian*; garioha, *Iroquois*	chori
dog	yzcuintli	aghwal, schari, *Shoshonese*; tkari, *Mixjeji*	zacur
throat	tuzquitl	seker, *Lesghian*; iakwal, *Araucan*	eztar
old	veue	vochor " hachooli, *Choctaw*	agure
evening	teotlac	sarrach, *Mixjeji*; sonrek, *Iroquois*	arrax, arrats
axe	tlateconi	adaganu, *Koriak*; atacarte, *Yuma*	aizkor
bread	tlaxcalli	lagul, *Yukahiri*; tikaru, *Shoshonese*	hazkurri
bow	tlaoitolli	ratla, *Koriak*; gahlotrahde, *Cherokee*	uztadarra
thunder	tlaquaqualaca	yekilkegie, urgirgerkin, *Koriak*	ehurzuri
river	atoyatl	uor, chyare, *Lesghian*; hahuiri, *Aymara*	uharre
earth	tlalli	delchel, *Koriak*; ratl, *Lesghian*	lur
child	acatl	jacuel, *Yuma*; jali, *Yeniseian*	aur
clothes	tlatqtl	retelkum, paltar, *Lesghian*	aldagarri, aldarri
knee	tlanquaitl	cconcor, *Quichua*; hizanosara, *Japanese*	zangar

ENGLISH.	AZTEC.	INTERMEDIATE FORMS.	BASQUE.
easy	velchiu-aliztli	illesu, *Circas*; arrangya, *Yukahiri*	errecha
shoulder	cuitlapantli	telpilgin, tschilpit, *Koriak*	sorbalda
silver	teoquitlatl	coluque, *Aymara*; kvartschili, *Georgian*	cilarra
speak	tlatoa	raton, *Iroquois*; arusi, *Aymara*	erran, erraitea
"	notza	ni, *Quichua*; hanasu, *Japanese*	mintza
five	macuilli	millgin, *Koriak*; marqui, *Sonora*	bortz
ten	matlactli	mari, *Araucan*; peeraga, *Dacotah*	amar
seven	chicome	shahemo, shacopi, *Dacotah*	zazpi
beard	tenchalli	hannockquell, *Shoshonese*; musur, *Lesghian*	bizar
to-morrow	muztli	mayyokal, *Yuma*; michar, *Georgian*	bihar
back	topuztli	kaptcher, *Koriak*; machol, *Lesghian*	bizkhar
"	"	hapar, *Yeniseian*; sobira, *Japanese*	guibel
walk	malquica	pulanujaha, *Yeniseian*; puriy, *Quichua*	ibilcea
blood	eztli	tleh, kleh, *Circassian*; huila, *Aymara*	odol
breast	telchiquiuh	tar, *Mizjeji*; teyga, *Yeniseian*	thilia
skin	cuatl	tsholoh, *Lesghian*; tshal, *Yukahiri*	azal, achal
nail	yztetl	oocheelah, *Iroquois*; onzshil, *Yukahiri*	atzazal
frog	cueyatl	kayra, *Quichua*; kayeru, *Japanese*	iguela
come	vallauh	ela, *Choctaw*; or, *Corean*.	el, hel
great	yzachipul	oboloo, *Shoshonese*; chvallal, *Lesghian*	zabal
tree	quauitl	kotar, " guet, hueta, *Lesghian*	zuhaitz
to-day	axcan	wakum, *Arancan*; tachan, *Mizjeji*	egun
cold	yztic	izits, *Shoshonese*; echta, *Circassian*	ozt
"	cecuiztli	hutseelo, xetchur, *Yuma*	otsbero
child	tetel-puch	hailpit, *Yuma*; bikh-jal, *Yeniseian*	mut-il
small	tepiton	dahab, tkivisa, *Lesghian*	tipia
boy, son	tepil-tzin	tiperle, *Sonora*; timir, chimir, *Lesghian*	seme
lip	tenxipalli	kuchibiru, *Japanese*; uku-fari, *Circassian*	ez-pana
man	oquichtli	chojashin, *Koriak*; haasing, *Adahi*	gizon
mouse	vecacotl	achacollo, achaca, *Aymara*; dsugoh, *Circass.*	sagu
mouth	camatl	simi, *Quichua*; khaipi, *Atacama*	auba
name	tocaitl	zar, *Lesghian*; chinna, *Iroquois*	izen, icen
sister	teciuapo	tsheebk, shupch, *Circass.*; cuhuba, *Muysca*	aizpa
black	yapalli	millh, *Yuma*; shawagare, *Shoshonese*	beltz
wind	ehecatl	acate, *Sonora*; ahekin, "	aicea
all	ixquich	hoahcasse, *Dacotah*; eezahk, *Circassian*	guci
enemy	teyaouh	toka, " taityok, *Corean*	etsaya
give	maca	muy-scua, *Muysca*; beckish, *Lesghian*	eman, emak
sick	cocoxqui	ccotas, *Atacama*; joatsh, *Yukahiri*	gaicho, gaitz
I	ne	nah, *Pueblo*; na, *Aymara*; na, *Lesghian*	ni
thou	te	too, " ta, " de, *Dacotah*	zu
he	ye	ihih, " uca, " eeah, "	hau

Thanks to the survival of Lesghian forms in *tl*, the disguise of the Aztec has been penetrated, and we are thus enabled to assert, first of all, that the apparently widely divergent Peruvian dialects, the Quichua, Aymara, Atacameno, &c., are really its near relations. There is therefore every reason to believe that the Peruvians were the Toltecs, who preceded the Aztecs as rulers of Mexico, and who, under their king, Topiltzin Acxitl, withdrew to the south in 1062, and there founded the kingdom of the Sun. The Peruvian annals place the accession of their first historical monarch, Sinchi Rocca, in the same year. Passing over the intermediate kingdom of Bogota, the home of the Chibchas or Muyscas, which was distinctively Peruvian in character, and another Toltec remnant, the Lencas of Honduras, we come to the north of the Aztec country, where the Sonora, Pueblos, and Paduca tribes dwell, who have already been associated with the Aztecs by several writers. To these I would add the comparatively small but philologically important Yuma and Pujuni fami-

lies. In all of these tribes we may recognize the barbarous Chichimecs through whom the Aztecs passed on their way to empire. But of the same race are the central stocks, the Dacotah and Pawnee; and to no other belong the eastern families of the Huron-Cherokees, and the Choctaw-Muskogees. The Algonquins of the north, like the Maya-Quichés of Central America, are of a totally distinct branch of the Great Turanian division. The samples of Mound Builder language furnished by the Davenport, the Grave Creek, and the Brush Creek Stones add their evidence to that of the written characters in favour of a connection of the Mound Builders with the Aztecs and related tribes. The Dacotah Mandans, the Choctaws, the Natchez, and the Aztecs, have been severally set forth as the Mound Builders. The true Mound Builders may have been none of these, but a distinct tribe of Allighewi or Alleghenies, for whom we must look elsewhere, still, however, to find them a portion of the same great family. Ancient traces of this tribe appear in the Hittite country of the Nairi in Mesopotamia, where Elisansu was situated; in the Alazonus river of Albania in the Caucasus; in the nation of the Halizoni of Pontus mentioned by Homer; in the Scythic Alazonians of Herodotus; and in Alzania, a mountain region of the Basques. It is not at all improbable that the ancient name survives in those of the Alasar and Allakaweah, sub-tribes of the Dacotahs, but this only tends to prove that a people of the same race as the Dacotahs, and not necessarily the Dacotahs themselves, were the Mound Builders.

There is abundant reason for believing the tradition of most of the American tribes I have mentioned to the effect that their ancestors passed over the sea or great river and traversed a region of intense cold before arriving at their destination in more hospitable climates. Kamtchatka must have been their point of departure from the Old World, whether they reached that point from the Siberian Desert or journeyed thitherward from Corea and Japan by the Kurile Islands. There they set foot on the Aleutian chain which carried them safely over to the coast of Alaska. In Kamtchatdale there are many Aztec traces, and some which exhibit an exaggeration of the peculiarity of Aztec speech with which this paper is mainly occupied. Such is the rendering of the Aztec verb *tlacotla*, to love, by the elongated but distinctly recognizable form *tallochtelasin*. And, with the Kamtchatdale, the Aztec connection, which has been illustrated by comparative vocabularies, embraces all the hitherto unclassified languages of Nor-

thern Asia and Europe. The same forms that prevail over a great part ot the American continent, somewhat disguised yet easily recognizable, are found in Japan and in Siberia, in the Caucasus and in Biscay.

Some time ago I alluded to a passage in the Paschal Chronicle in which the Dardanians of the Troad are referred to as Hittites, and since then Professor Sayce has seen reason for connecting the whole Trojan family with that ancient and illustrious people. Strabo tells us that at Hamaxitus in the Troad the Teucri, near relations of the Dardani, consecrated a temple to Apollo Smintheus as a memorial of the destruction of their bow-strings and other leathern articles by an army of rats or mice. The same story is told by Herodotus of the Assyrian army, opposed by the Egyptian Sethos, whose name, being the equivalent of Sheth, is truly Hittite. This same story lives in America among the Utes of the Paduca or Shoshonese family, as related by Professor Powell, and among the Muskogees, as told by Dr. Brinton. Hamaxitus, the Trojan town where the legend was localized, was in all probability a transported Hittite Hamath, for in the form Hamaxia it occurs in the peculiarly Hittite country Cilicia, where Cetii dwelt in ancient times, and where Hittite kings held limited sway in the days of Rome's supremacy. The Scythic Hamaxoeci very probably bore no closer relation to the chariot or *Hamaxa* than the Muskogees do to *musk*. These words Hamaxitus, Hamaxia, and Hamaxoeci designated a tribe, sub-tribe or caste, which originally had its chief representatives in the Syrian Hamath. They were scribes, the most likely people to preserve and hand down traditions of the past, the Amoxoaquis of the Mexicans, and the Amautas of the Peruvians. Through them this legend, and many others which recall old world stories, have found a resting-place on the American continent. Many writers on comparative mythology have been led to connect American tribes with Aryans and Semites by failing to recognize what Accadian studies have fully established, that the Turanians were the instructors in mythology and in many other things of these more highly favoured divisions of the human race.

The decipherment of the Hittite and Siberian inscriptions by the Aztec is but the first step in the solution of problems relating to ancient Old World populations, which are supposed either to have been exterminated or to have lost their independent existence. And the superior purity of the Aztec language as preserved by a literary

people, spite of its dialectic peculiarities, will enable the philologist to shed light on many points of etymology and construction in the languages of Europe and Asia to which it is related. Take, for instance, the world *totolh-tetl*, an egg. Its meaning is clear, for *totolh* is *tototl* a fowl, and *tetl* denotes a stone. By a simple postposition of the nominative, therefore, the Aztec word for egg means the stone of the bird. In Yukahirian the word used is *nonton-daul*. Now *nonda* means a bird in Yukahirian, a form doubtless of the Lesghian *onotsh*, and the Japanese *ondori*, a fowl; but *daul*, which is just the Aztec *tetl*, does not now designate a stone in that language. The form has undergone change and is now *kell*, but there can be no doubt that *daul* or *tol* was once the Yukahirian name for stone, as it now is the Mizjeji, Corean and Choctaw form. The Basque word, which I have not found any explanation of among the Basque etymologists, is *arrolchia* or *arroltz*. Here the order of the Aztec and the Yukahirian is inverted, for *arri* denotes a stone, and *ollo* or *oilo*, a fowl. The final *chi* or *zi* before the article *a*, is the mark of the genitive which is now *aco* or *eco*. Hence, literally translated, *arrolchia* is "stone fowl of the." The Iroquois has entirely lost the etymology of his word *onhonchia*, in which the Basque *r* and *l* have been replaced by *n*; and the same is the case with the Peruvian, who, by following his usual practice, like the Lesghian, of removing the initial vowel, and simply changing the *l* to *n*, makes the word *runto*. The Circassian *kutarr* is probably of the same composition, for *kut* should represent *kuttey*, fowl, and *arr*, though not now a Circassian word, was so at the time when Circassians and Basques were one people, and derived their respective tribal and local names, Chapsuch and Guipuzcoa, from the Hittite land of Khupuscai. It is interesting to note, as exhibiting the vicissitudes of language, that the Corean, who calls a stone *tol* or *tor*, retains *arr*, the primitive term, to denote an egg, just as the Aztecs frequently employed *tetl* to express the same without any prefix.

There is a Basque word, the derivation of which puzzles the lexicographers, although some have ventured to derive the only Basque term denoting a boy from the Latin. It is *mutil*, or with the article *mutilla*. In Lesghian, *motshi* is a boy, in Japanese, *musuko*, in Sonoro, *te-machi*; but, as a rule, the *m* of these languages is replaced in others of the Khitan family by an ordinary labial. A similar difficulty in Basque attends the connected word *illoba*, which may

mean a nephew or niece, or a grandchild. I am disposed to see in these terms the same word as the Aztec *tetelpuch*, which appears to mean "the offspring of somebody," or "of a person," for *tetech*, which in composition becomes *tetel*, denotes personality. The Aztec *puch*, offspring, would thus be the same as the Basque *ba*, and *mut*. That the *mut* of *mutil* corresponds with the *mus* of the Japanese *musuko*, appears from the comparison of another Basque word of similar form, *mutchitu*, mouldy. This answers to the Japanese equivalent *museta*, as *mutil* does to *musuko*. The Aztec word for mouldy is *poxcauhqui*, and, although there can be no connection between mustiness and offspring, answers in form to *puch*, as *mutchitu* to *mutil* and *museta* to *musuko*. The *ba* of *illoba* is but an abbreviated form of *puch*, such as appears in the Aino *po*, the Yeniseian *puwo*, and the Circassian *ippa*. The Basque word for child is *nerabea*, *norhabe*, which connects with *nor*, *norbait*, somebody, just as the LooChoo *worrabi*, also meaning child, shows its relation to *waru*, the Japanese *aru*, likewise denoting "somebody." It appears therefore that "somebody's wean" is a thoroughly Khitan conception. In Georgian, *boshi* which may be taken as the root word, means "child," and in Lesghian *vashsho*. But the Aino *vas-asso* and *bog-otchi* seem to be compound terms, like the Choctaw *poos-koos* and the Dacotah *wah-cheesh* and *bak-katte*. Similar forms are the Iroquois *wocca-naune*, and the inverted Muyscan *guasgua-fucha*. The abbreviation of *boshi* or *puch* to *ba*, *be* or *bi*, as in the Basque and LooChoo, finds its parallel in the Yeniseian *dul-bo*, a doubly apocopated *tetel-puch*. The Yuma *hail-pit* seems almost to reproduce the Basque form, which inverted would read *il-mut*. One of the Sonora dialects, as we have seen, gives *te-muchi* for boy; one of the Iroquois, *ihiha-wog*; the Choctaw, *chop-pootche*; and the Shoshonese, *ah-pats*. In the Old World, the Corean furnishes *tung-poki*; the Kamtchatdale, *kamsanapatch*, a long form as in the Dacotah *menarkbetse*; and the Yeniseian, *pigge-dulb* and *bikh-jal*. But the Yeniseian and Kamtchatdale also designate a son by the simple word for offspring, *bit*, and *petsch* in the respective languages. In the Georgian, Circassian, and Peruvian Aymara, this simple form seems to be reserved for the girls, for daughter in these languages is *bozo*, *pchu*, and *ppucha*. The Aztec prefixes to the word offspring *puch*, one of its terms denoting woman, female, the whole being *teich-puch*. This is the *tshide-petch* of the Kamtchatdale, and, with inversion of parts, the *bai-taga* of the Yukahiri. Other corres-

ponding Khitan forms for girl, daughter, are the Circassian *pus-pa*, the Yeniseian *bikh-jalja*, the Koriak *gna-fiku* and *goe-behkak*, the Kamtchatdale *uchtshi-petch*, the Corean *bao-zie*, and the Japanese *musu-me*; and, in America, the Paduca or Shoshonese *wya-pichi*, the Dacotah *weet-achnony*, and the Iroquois *kaunuh-wukh* and *echrojehawak*. The Basque word for girl, *ala-ba*, *ala-bichi*, is in harmony with *illoba*, *nerabea*, and the inverted *mut-illa*, and corresponds with the Yeniseian *bikh-jalja*. Besides these more conspicuous forms there are many others which exhibit a common formation. Among the Yuma words denoting boy, and the equivalents of *hail-pit* in other dialects, occur *her-mai* and *yle-moi*, in which the Basque *mut* and Japanese *musu* are abbreviated into *mai* and *moi*. Of the same structure are the Peruvian Quichua *huar-mà* and the Circassian *ar-ps*. Two other words for boy, the Japanese *bo-san*, and the Araucanian *bo-tum*, belong to the same category; and there are many other forms, such as the Adahi *talla-hache*, in which the labial of *boshi* or *puch* has been converted into an aspirate, to which I need refer no farther. The Aztec *tetel-puch* and *teich-puch* are the types of the many terms mentioned, which exhibit the singular agreement, with phonetic variations, of the Khitan languages in the formation of these compounds.

A very common element in compound Aztec words is *palli*, which, besides denoting colour as in *ya-palli*, black, and *quil-palli*, green, appears to have the meaning of "contents, belonging to," just as the Japanese *iro* means colour, and *iru*, to hold or contain. So in Basque, *bal* is a root denoting colour in the abstract, and *bar*, a corresponding root signifying contents. In Aztec *tenxi-palli* means lip, but its derivation is only apparent in Japanese, in which language the word for lip is *kuchi-biru*. Now *kuchi* is the mouth, and *biru* is the original of *iru*, to hold, contain or enter. The Aztec *tenxi* does not appear in the dictionaries as a word for mouth, *camatl* being the term employed; but the related Shoshonese family furnishes *atongin*, *tungin*, and the Adahi, *tenanat*. The Circassian lip is *uku-fari*, plainly the same word as the Japanese and Aztec, although *uku* is not the present Circassian term for mouth. The Corean form is *ipsi-oor*, in which *ipsi* represents the Corean *ipkoo*, the mouth, and *oor*, the Japanese *iru* or *biru*. So also the Natchez adds *er* to *heche* the mouth, and calls the lip *ehec-er*. The Araucanian, from a primitive word *ia*, like the Dacotah *ea*, the Yuma *yu*, the Circassian *je*, *ja*, the Corean *ii* and the Basque *aho*, all meaning mouth, forms, with

the equivalent of *palli*, *biru* and *fari*, *ia-pelk*, lip. The Circassian alone retains the sound of *itsha*, *utsha* for mouth, which appears in the inverted Lesghian *mur-tschi*, and Mizjeji *bar-dash*, their equivalenti for *uku-fari*. In Iroquois the lip is *osk-wenta*. By the conversion of *r* and *l* into *n*, which characterizes the Iroquois in comparison with most of the other Khitan languages, *wenta* represents an original *bar*, *pel*, *berta* or *palta*. The double meaning of this root which has appeared in the Aztec *palli*, the Japanese *iro* and *iru*, and the Basque *bel* and *bar*, holds good in the case of the Iroquois, for colour is *wensera*, in which *wen* is the radical, and *iowente* means "accompanying or belonging to." The form *wen* is by no means so common in Iroquois as to make this a chance coincidence. The first part of the word *osk-wenta* is an abbrevation of a common form denoting the mouth. In the Basque we are warranted in rejecting Van Eys's derivation of *ezpana*, the lip, from the root *es*, to shut, inasmuch as the same root in *eztarri*, the throat, would be manifestly out of place. In *ez* therefore we detect the ancient form for mouth which the Circassian gives as *itsha*, and the Natchez as *heche*. And in *pana*, when it is remembered that the change of *l* to *n* is not uncommon in the Basque dialects, there is no difficulty in seeing an archaic *pala*, even if the Iroquois *wen* did not justify the connection. The Aztec *tenxipalli* has derived its *enxi*, for the *t* is prosthetic, from such a strengthened form of the *ez*, *eche*, mouth, as is found in the Yukahiri *anga*, *angya*, and in the Lenca *ingh*. The following table will set more clearly before the eye these relations of the Khitan languages in the Old World and in the New :—

FORMS OF THE AZTEC *palli*.

	COLOUR.	CONTENTS, PERTAINING TO	LIP.
Aztec	*palli*	*palli*	*tenxi-palli*
Japanese	*iro biro*	*iru*, *biru*	*kuchi-biru*
Iroquois	*wensera*,	*iowente*	*osk-wenta*
Basque	*bel*	*bar*	*ez-pana*

A somewhat similar instance is afforded in the Aztec word for leaf, *iatla-pallo* or *quauhatla-palli*, of which the first part is the word denoting a tree. The same is the case with *eatcha* in the corresponding Yuma term *eatcha-berbetsen*. But the *tlel* of the inverted Kamtchatdale *bil-tlel*, the *djitsha* of the Yukahiri *pal-djitsha*, and the *zeli* of the Georgian *pur-zeli*, no longer mean tree in these tongues. The Kamtchatdale now uses *utha* and *uuda*, diminished forms of the

Lesghian *hueta* and the Basque *zuaitz*. The Yukahiri has conformed to the Lesghian *dzul*.in *tshal;* and the Georgian, with its *che, tka,* and *tcheka,* more nearly approaches the Yuma and other American forms. Still *tlel, djitsha* and *zeli* are thoroughly Khitan in character, answering to the Circassian *zla,* the Basque *zuhatsa,* and the Lesghian *dzul* and Yukahiri *tshal*. Such examples suffice to show how difficult it must be to gain a thorough acquaintance with the structure of our American languages, without having reference to the stock from which they are derived, as well as the paramount value of these languages in all matters affecting the construction of the Basque and Caucasian, the Siberian and Japanese tongues.

Whether the Aztec *tl* was an original element in Hittite speech, or a corruption arising after the dispersion in 717 B.C., we shall not know definitely until the inscriptions of Syria and Asia Minor, of India, Siberia, and Japan, yield a vocabulary of sufficient extent to enable us to judge. It is very probable that it existed as a substitute for *r* in certain Khitan tribes from a very early period, since, in the land of the Nairi, the Assyrian inscriptions mention a town Citlalli, in which we recognize the Aztec word for star, the equivalents for which in Araucanian, Atacameno, Shoshonese, Aino, Lesghian and Basque are *schalela, halar, shul, zirari, suri,* and *izarra.* The land of the *Nairi* or *Nahri,* the *Naharina* of the Egyptian records, has been generally regarded as a form of the Semitic *Naharaim,* the rivers, whence the designation Mesopotamia. But the word is purely Turanian, and designates primarily a people, not a country. The Egyytian form is the most perfect, as it preserves the medial aspirate and retains the Hittite plural in *n.* It is just the Aztec national designation *Nahuatl, Nauatl,* or *Navatl,* which, by the application of the law of phonetic change, becomes *Nahuar, Nauar* or *Navar.* The Aztec word means "that which is well-sounding, or a fluent speaker," but most of the words derived from the same root have either the meaning of *law* or *measure* or of *interpretation.* The fluent speaker probably was looked upon as one who spoke with regard to the laws of language and in measured tones, and the interpreter as one who converted the idiom of barbarians into the well-regulated language of the Aztecs. The Japanese preserve the word in two forms, *nori,* meaning law or measure, and *naori,* translation. In Basque it is represented by *neurri,* measure, and this in all probability is the same word as Navarre, a Basque province. As Khupuscai and the

land of the Nahri are united in the Assyrian inscriptions, so, in Basque geography, are Guipuzcoa and Navarre. The Scythic Neuri of Herodotus were probably members of the same family. The Niquirans, who are Aztecs, settled in Nicaragua, preserve the ancient name but have hardened the aspirate into a guttural.

More than thirty years ago that veteran ethnologist, Dr. Latham, wrote the following: "The Kamskadale, the Koriak, the Aino-Japanese, and the Korean, are the Asiatic languages most like those of America. (Afterwards he includes the Yukahiri and elsewhere connects that language with the Yeniseian.) Unhesitatingly as I make this assertion - an assertion for which I have numerous tabulated vocabularies as proof—I am by no means prepared to say that one-tenth part of the necessary work has been done for the parts in question; indeed it is my impression that it is easier to connect America with the Kurile Islands and Japan, &c., than it is to make Japan and the Kurile Islands, &c., Asiatic." Nothing can be truer than the above statement made by one whose name should carry the greatest weight with all his scientific utterances to the minds of scholars. It is therefore simply incomprehensible how a writer on philological subjects of such high standing as Mr. Horatio Hale could be led to say, "Philologists are well aware that there is nothing in the languages of the American Indians to favour the conjecture (for it is nothing else) which derives the race from Eastern Asia." I venture on the contrary to assert that there is no philologist worthy of the name who, having carefully studied the languages of the New World and the Old with which this paper deals, has come to any other conclusion than that reached by Dr. Latham and myself. And if Mr. Hale will simply follow up the relations of the Basque, which he wisely connects with our American aboriginal languages, he will soon find himself among those very peoples of Eastern Asia whom he so summarily dismisses. Dr. Latham's Peninsular Mongolidae, including the Yeniseians, and the Americans, are neither Mongolic, Tungusic, (with the exception of the Tinneh , Finno-Samoyedic, Dravidian, or Monosyllabic. They have relations in India among the aboriginal northern peoples, and the Kadun or red Kariens of Birmah belong to the same race. But, with these exceptions, the Khitan do not connect with the Asiatic populations. Not till we reach the confines of Europe and Asia in the Caucasus, where another unclassified group of languages makes its appearance, do we find the relatives

of the colonizers of America, and through them effect, what Mr. Hale would do *per saltum* across the Atlantic, a union with the Basques.

From these general considerations I turn to the special work set forth in this paper, that namely which exhibits the relation of the Aztecs to the Khitan family in general, and in particular with those branches of it which are found in the neighborhood of the ancient Hittite civilization. The meagreness of my vocabularies of the Caucasian languages compelled me to illustrate their connection by the closely related Basque in the case of the Hittite inscriptions which I recently translated. Some examples of the relation of the Hittite language spoken in Syria and Mesopotamia in the 8th and preceding centuries B.C., may fitly close the argument in favour of the Hittite or Khitan origin of these and their related languages.

COMPARISON OF HITTITE FORMS EROM THE MONUMENTS.

English.	Hittite.	Basque.	Japanese.	Aztec.
dependence	kakala	katalo	kakari	cacalic, cetilia
incite	kasakaka	kitzikatu, kilikatu	keshikake	cocolquitia
oppose	kakeka	jauki	giyaku	ixquaqua
desirous	manene	min	mune	mayanani
beseech	neka	nastu	negau	notza
modest	simaka	zimiko	tsume	temociui
country	kane	gune	kuni	cana
cut	kara	zilhetze	kiru	xeloa
he	ra	hura, hau	are	ye
small	sasa	chiki	sasai	xocoa
put	tara	ezarri	ateru	tlalia
fight	tiketi	zehatu, etsaigo	tekitai	teyaotia
between	neke	nas, nahas	naka	netech
hastily	sakasakasa	takataka	sekaseka	iciuhcayotica
destroy	kasa	chikitu	kachi	cacayaca
lay waste	susane	zuzi	susami	xixinia
accord	kane	on-gune	kanai	cen
come	al	el, hel	iru, kuru	vallauh
house	taku	tegi	taku	techan
I	ne	ni	mi	ne
within	tata	ta, hetan	tate	titech
at	ka	gau	oku	co
in	ne	an, n	ni	
vex	nebala	———	naburi	navallachia
hear	kika	———	kiki	caqui
ruler	basa	———	bushi	pachoa
friend	tineba	———	tomobito	tenamic

From these examples it appears that the best living representative of ancient Hittite speech is the Japanese, which, with the Aztec down to the time of Spanish conquest, has never ceased to be a literary language. Standing midway between the long-forgotten Hittite

civilization of Syria and the now extinct native civilization of Mexico, Japan affords the most satisfactory starting point for the investigation of problems of world-wide interest that find their centre in the Khitan name. In its name Yamato it shows a closer connection with Hamath than with the land of the Nahri in Mesopotamia. As the home, therefore, of the scribes, whom the Peruvians called Amautas and the Aztecs Amoxoaquis, literature naturally flourished in its islands; and the believer in Holy Writ will see in Japanese culture and prosperity the result of the blessing of Him who is governor among the nations upon the Kenite "scribes that came of Hamath, the father of Beth-Rehob," Hittites indeed, but nobler than their fellows.*

Mr. Buchan was of opinion that it was impossible to pronounce an opinion upon the paper without examining the lists of words carefully, but the conclusion that the American Indians reached this continent from north-eastern Asia seemed exceedingly reasonable. He must, however, differ from Prof. Campbell in regard to the relationship of the Hinos and Japanese. Recent accounts had confirmed him in the view that they were radically different in language as well as in physique. He might mention that it had been clearly established that the Hinos were, as according to a pet theory ot his they ought to be, a white race, seeing that they inhabited a moist and cloudy region. The contradicting accounts of previous travellers as to their colour were due to the Hino abhorrence of water, at least when applied externally.

Mr. Notman, Mr. Shaw, Mr. Dunlop and Mr. Murray also took part in the discussion.

* Mr. VanderSmissen has kindly called my attention to the fact that Professor Schleicher, whom in my former paper on the Khitan Languages I inadvertently represented as constituting grammatical construction the soul of language, really gives great prominence to the phonetic element, especially to that portion of it which expresses relation. I am glad to acknowledge this correction of an extreme statement by so competent a disciple of the great German philologist.

Mr. VanderSmissen also read a paper by the Rev. Dr. MacNish, of Cornwall, entitled :—

THE GAELIC TOPOGRAPHY OF WALES AND THE ISLE OF MAN.

In a paper which I had the pleasure of sending to the Canadian Institute during last year, I endeavoured to prove, by the examination of topographical names in England and Scotland and Ireland, that Celts who spoke Gaelic must have preceded the Cymry in the occupation of the British Isles. On the strength of evidence which appeared to me satisfactory, I came to the conclusion that "the first powerful stream of immigration into Great Britain and Ireland was Gaelic; that the Scottish Gaels are the representatives of those Celts who were the first to enter Britain and to travel northwards from the South of England to Scotland; and that the remote ancestors of the Scottish Gaels and the Celts who were the first to people Ireland, were one and the same people and spoke the same language."

I propose in this paper to examine the Topography of the Isle of Man and of Wales, in the hope that corroborative evidence can thus be obtained in favour of the theory, that Celts who spoke Gaelic preceded the Cymry in the occupation of Great Britain; and that the arrival of the Cymry must have been much later than that of the Gaels whose language is still discernible, after the glide of many centuries, in the names of headlands and mountains, and lochs, and bays, and rivers. It is reasonable to conjecture that the earliest occupants of Britain wended their way westward, and that a Celtic population settled in the Isle of Man long before the Romans invaded Britain; and that from Man many Celts must have passed into Ireland and at different times into Scotland. The Topography of the Isle of Man; the names which still survive and which a succession of foreign masters was powerless to obliterate; the language which the Manksmen speak down to our own day; and the literature which they have, though it is not very extensive,—combine to prove that the Isle of Man and its inhabitants are normally Gaelic, and that Manx is closely allied to Irish and especially to Scottish Gaelic. Dr. Joyce in his interesting work, *Irish Names of Places*, (Vol. I, p. 163), has this reference to Manannan Beg Mac y Leirr, who, the Manksmen aver, was the founder, father and legislator of their country. "One of the

most celebrated characters among the people, *i.e.*, the Tuath de Danaan, was Manannan Mac Leir, of whom we are told in Cormac's Glossary and other ancient authorities, that he was a famous merchant who resided in and gave name to Inis Manann, or the Isle of Man . . ." The conjecture has been advanced, that the term Mannin is compounded of *meadhon*, middle, and *in*, an island; and that accordingly, it is a purely Gaelic word, signifying "*the middle island.*" A glance at the map will show, that the Isle of Man is situated in a very convenient position so far as England, Ireland and Scotland are concerned; and that in the days of irregular and unprincipled warfare, it could not fail to be involved in the continual struggles that were going on in those kingdoms. Three armed legs form the present armorial bearing of the Isle of Man. The motto, *Quocunque jeceris stabit*, inasmuch as no transposition of the words can alter the true meaning, may be regarded as an ingenious allusion to the three alternatives which Man in the days of its independence possessed, of leaning for support on one or more of its more powerful neighbours. That the Manksmen could and can speak their own Gaelic after being subject to their Welsh neighbours for 400 years, and to the Danes for 153 years, and to the Norwegians for 200 years, and after owning the sway of England and Scotland for 139 years before the Isle of Man became the property of the Stanleys with whom it remained for 330 years, when it passed into the possession of the Lords and Dukes of Atholl, who surrendered every claim to it in 1829,—goes very far to show how strong the life of a language can be, and how its vitality can continue and be vigorous even when unfriendly forces of a powerful kind are, it may be, intent on destroying it.

Taylor in his *Words and Places*, (pp. 260, 261), maintains that *Man* signifies a district. He goes on to state that "the map of the Isle of Man contains about four hundred names, of which about 20 per cent. are English, 21 per cent. Norwegian, and 59 per cent. Celtic. These Celtic names are all of the most characteristic Erse type. It would appear that not a single colonist from Wales ever reached the island, which, from the mountains of Carnarvon, is seen like a faint blue cloud upon the water. There are 96 names beginning with *Balla*, and the names of more than a dozen of the highest mountains have the prefix *slieu*, answering to the Irish *sliebh* or *sliabh*. The Isle of Man has the Curraghs, the Loughs, and the Allens of Ireland faithfully reproduced." Taylor was doubtless at pains to

make an accurate examination of the topographical names of Man. It is in the highest degree surprising that, after all the changes which passed over the Isle of Man, and in spite of the numerous languages which were spoken by those who successively exercised authority over its inhabitants, 59 per cent. of the topographical names should still be Gaelic, commemorating thus the early and powerful presence of the Gaels in the Island long before, it may be, Cæsar invaded Britain, or the Cymry forced their way as later Celts into the Albion of Aristotle. In his introduction to his Irish Grammar, Dr. O'Donovan thus writes: "The Manx is much further removed from the Irish than the Gaelic of Scotland. Its words are principally obscured by being written as they are pronounced without preserving the radical letters as in Irish." The translation of the Holy Scriptures into Manx forms the most important part of Manx Literature. The translators went avowedly on the principle of spelling words phonetically, of disregarding etymological considerations, and of making as near an approximation as might be possible to the manner in which the language was spoken, in order that every Manksman could easily read and understand the Scriptures in his native tongue. It naturally happens that no small ingenuity is at times necessary to discover the exact value of certain sounds and words in the Manx language as it is written. The judicious remarks of Dr. Joyce, (Vol. I, pp. 1, 2, 3,) apply with peculiar strikingness to the topographical names of Man:– "The interpretation of a name involves two processes, the discovery of the ancient orthography, and the determination of the meaning of this original form. . . . A vast number of our local names are perfectly intelligible as they stand in their present Anglicized orthography, to any person who has studied the phonetic laws by which they have been reduced from ancient to modern forms . . . In numerous other cases, where the original forms are so far disguised by their English dress as to be in any degree doubtful, they may be discovered by causing the names to be pronounced in Irish by the natives of the respective localities. When pronounced in this manner they become in general perfectly intelligible to an Irish scholar . . . The meaning of a name otherwise doubtful will often be explained by a knowledge of the locality."

Words beginning with *Baile* are very common in Scotland, and especially in Ireland. *Baile* signifies a farm, a village, or town. Indeed, a casual comparison of the names in Man, and Scotland, and

Ireland, that begin with *Baile*, will show that there is a great similarity if not an identity between them. It will be sufficient to adduce a few examples of the presence of *Baile* in the Topography of Man :—

Bailegawne, *baile'ghobhainn :* the smith's town.
Bailenahown, *baile na h-aimhne :* the town of the river.
Balladoole, *baile 'n tulaich :* the town of the knoll.
Ballaquane, *baile'chuain :* the town of the ocean.
Ballaquinney, *baile'chuinne :* the town of the corner.
Balnabarna, *baile* and *bearna*, a gap or fissure.
Ballamahow, *baile* and *magh*, *a field ;* Irish, *Mayo*.
Baldwin, *baile* and *aoduinn*, a brow or face.
Ballamona, *baile* and *monadh*, *a moor*.
Ballawhane, *baile* and *uaine*, green.
Ballaharry, *Ballagharaidh*, *baile* and *garadh*, a den.
Balloun, *baile* and *amhainn*, a river.
Ballaglass, *baile* and *glas*, grey.
Balla Kilmorrey, *baile*, *cill*, a church or graveyard, and *Muire*, Mary.
Ballysallach, *baile* and *salach*, filthy.
Ballaugh, *bealach*, *Balloch :* an opening or defile.
Ballamonamoar, *baile* and *monadh mor*, the large moor.
Ballure, *baile* and *ur*, new.
Ballacowle, *baile* and *cuil*, a corner.
Ballacooley, *baile* and *coille*, a wood.
Ballaliece, *baile* and *leac*, a flat stone.
Ballacreggan, *baile* and *creag*, a rock.
Ballamagher, *baile* and *machair*, a field.
Ballnakilley, *baile* and *cill*, a church-yard.
Ballaskyr, *baile* and *sgeir*, a rock.
Ballabooie, *baile* and *buidhe*, yellow.

Words identical with those which have now been cited, are of frequent occurrence in the Topography of Scotland and Ireland. I have given the Gaelic derivation or equivalent of the names which have been taken from the Topography of the Isle of Man. Their Gaelic origin is unmistakable ; and hence the inference may be reasonably drawn, that the same people gave names in the Isle of Man, in Scotland, and in Ireland, to the places in which *Baile* is found as one of

the constituent elements, and that the language which was then spoken in Man and Scotland and Ireland was one and the same.

The names of hills and glens in the Isle of Man are likewise Gaelic, *e.g.* :—

Slieu mayll, *sliabh*, hill : and *maol*, bare.
Cronk na h-eiric, *cnoc*, hill : *eirig*, a ransom.
Cronk na Kielan, *cnoc*, *hill* : and *ceolan*, faint music.
Slieuwhallin, *sliabh* and *aluinn*, lovely.
Cronk Keeillowan, *cnoc*, *cill*, and *Eoghann Hugh* : Ewan.
Knockaloe, *cnoc* and *loch*, a lake.
Cronk ny marroo, *cnoc na marbh*, dead.
Slieudhoo, *sliabh* and *dubh*, black.
Cronkbourne, *cnoc* and *burn*, water.
Cronkurleigh, *cnoc* and *iolaire*, an eagle.
Glentrammon, *gleann*, Manx *glione*, a valley, and *druman*, a ridge or boortree.
Glen Darragh, *gleann* and *darach*, oak.
Glen Moy, *gleann* and *magh*, a plain.
Glion Mooar, *gleann* and *mor*, large.
Gliongawne, *gleann* and *gobhainn*.
Glenfaba, *gleann*, *faigh*, pasture, and *ba*, cattle.
Glencutchery, *gleann* and *cruitearach*, the occupation of a harper.
Glendoo, *glenn* and *dubh*, black.

So apparent is the Gaelic origin of the names of hills and valleys in Man, that any one who has a knowledge of Gaelic can with great facility determine the meaning of the names in question.

Poolvash is compounded of poll, a pond or pool ; and *bas*, death, the pool of death.
Port ny-Hinshey, *port*, a harbour ; and *innis*, an island ; *port na h-innse*, the harbour of the island. Such was the original name of the harbour of Peel.
Maugherakew, *machair*, a plain ; and *ceo*, mist.
Bowmaken, *bogha*, a bow ; and *ceann*, head.
Rushen, *rudha*, a promontory ; and *sean*, old.
Rue, *rudha* : a point.
Rievalle, *righ*, a king, and *baile*.
Ayre, *airidh* : a shealing.
Shellach point, *seileach*, willow.

There are many words beginning with *ceann*, a head, whose Gaelic origin is quite evident, *e.g.* :—

Kentraugh, *ceann*, a head ; and *traighe*, shore.
Kiondroghad, *ceann* and *drochaid*, bridge.
Kenmoy, *ceann* and *magh*, a plain.
Kinskae, *ceann* and *sgiath*, a wing.
Kionsleau, *ceann* and *sliabh*.
Kenna, *ceann* and *ath*, a ford.

Such words as these indicate at once that they are of Gaelic origin, and that the Celts who imposed such names on the prominent physical features of the Isle of Man spoke the language which has been perpetuated over many centuries in the Highlands of Scotland.

Lhergydoo, *learg*, a slope, and *dubh*, black.
Slegaby, *slige*, a shell ; and *buidhe*, yellow.
Keillvael, *cill* and *maol*, bare.
Douglas, *dubh* and *glas*, grey.
Sulby, *suil*, an eye ; and *buidhe*, yellow.
Lazayre, *lios*, a fort ; and *airidh*, a shealing.
Lhen moar, *lean*, a plain ; and *mor*, large.
Garff, *garbh* : rough.
Braddan : a salmon.
Cas na h-owne : the foot of the water.
Strathallan, *srath*, a valley ; and *aluinn*, splendid.
Cloughbane, *clach*, a stone ; and *ban*, white.
Loughan a yeeah, *lochan* a little lake ; and *geadh*, a goose.
Cregnesh, *creag*, a rock ; and *innis*, an island.
Caoilban, *caol*, narrow ; and *ban*, white.

It would be very easy to adduce examples in abundance from the Topography of Scotland and Ireland in which such roots are present, as *baile*, *amhuinn*, *monadh*, *cill*, *magh*, *maol*, *creag*, *sgeir*, *cnoc*, *loch*, *gleann*, *port*, *innis*, *learg*, *ceann*, *rudha*, *clach* ; roots which are of constant occurrence in the Topography of the Isle of Man. It is reasonable to conclude, that the power of the Gaels in the Isle of Man was paramount at some time in the far-off past, seeing that the successive waves of conquest which passed over the Island have failed to obliterate the traces of the Gael, and to destroy the proofs that names of rivers and hills and valleys furnish, regarding the people whose time of predominant occupation was so long as to enable them to leave

indelible footprints of themselves and of their language in the names which the Topography perpetuates for the information of posterity.

Thomas Stephens, the well-known author of the Literature of the Kymry, avers, "that the Welsh or Kymry are the last remnant of the Kimmerioi of Homer and of the Kymry, the Cimbri of Germany." It is possible to cite the authority of two learned Welshmen in favour of the theory that the Gaels preceded the Kymry in the occupation of Britain. Edward Llwyd, the famous author of the *Archæologica Britannica*, who expended five years in travelling among the portions of Great Britain and Ireland where the Celtic languages were spoken, and who is justly regarded as the Father of Welsh Philology, thus writes in his Welsh preface to his book: "Nor was it only North Britain that these Gwydhelians (Gaels) inhabited in the most ancient times, but also England and Wales . . . Our ancestors did from time to time drive them northward . . . From Kintyre, in Scotland, where there are but four leagues of sea, and from the County of Galloway and the Isle of Man, they passed over into Ireland, as they have returned backwards and forwards ever since . . . There are none of the Irish themselves, so far as I know, . . . who maintain that they had possession of England and Wales. And yet, whoever takes notice of a great many of the names of the rivers and mountains throughout the kingdom, will find no reason to doubt that the Irish must have been the inhabitants when those names were impressed upon them, *i.e.*, upon the rivers and mountains." In his *Celtic Britain*, (p. 4,) Professor Rhys, of Oxford, who is himself a Welshman, and a Celtic scholar of large attainments, asserts that the Goidels (or Gaels), were undoubtedly the first Celts to come to Britain, as their geographical position to the west and north of the others would indicate. In connection with the Ogam Inscriptions, which are found in Wales, he remarks in his *Celtic Britain*, (p. 213,) that the Goidels belonged to the first Celtic invasion of Britain, and that some of them passed over into Ireland and made Ireland also Celtic. Some time later there arrived another Celtic people with another Celtic language. "These later invaders," he writes, "called themselves Brittons, and seized on the best portions of Britain, driving the Goidelic Celts before them to the west and north of the Island; and it is the language of these retreating Goidels of Britain that we have in the old Inscriptions and not of Goidelic invaders from Ireland. Their Goidelic speech, which was driven out by the ever-

encroaching dialects of the Brythons, was practically the same language as that of the Celts of Ireland, of Man, and of Scotland." As Lhuyd and Professor Rhys give such an unambiguous opinion respecting the earlier presence of the Gaels in Britain, it may fairly be expected that the Topography of Wales will lend strength to the conclusions of those Welsh scholars.

The word *Aber* is of frequent occurrence in the Topography of Wales. It is in all likelihood a compound of *ath*, a ford, and *bior*, water—waterford.

In my previous paper on the Gaelic Topography of Britain, I adverted to the theory which was first advanced by Chalmers and which has as its advocates Dr. MacLauchlan, and Mr. Taylor, the author of *Words and Places*,—that, as Dr. McLauchlan contends, "the Generic *Aber* is in Scottish Topography found uniformly associated with specific terms purely Kymric," and that, as Mr. Taylor contends, "the Cymry held the Lowlands of Scotland as far as the Perthshire hills. The names in the valleys of the Clyde and the Forth are Cymric and not Gaelic." I remarked that Robertson and Skene have successfully refuted the theory in question. It is certainly a singular fact that if the Topography of Strathclyde is Cymric and not Gaelic, there are no *Abers* in the counties of Selkirk, Peebles, Ayr, Renfrew, Lanark, Stirling, Dumbarton and Galloway. Robertson, after examining the theory of which mention has been made, is fully justified apparently in employing this language in his Gaelic Topography of Scotland, (p. 512): "All the great features of nature within Scotland attest to the truth of the Caledonians being the first race; the mountains and the valleys all speak to us in their language —the *Gaelic* and not in *Welsh*. The author has proved beyond all controversy that there is not a mountain to be found in Scotland which bears a Welsh name, not a lake or river." *Aber* is of common occurrence in the names of places that lie along the sea-coast of Wales, *e. g.* :—

Abergeley : the confluence of the white river, *(geal)*.
Aberconwy, *aber* and *conabhuinn* : confluence of rivers.
Aberhonnddu, *aber* and *abhuinn*, river ; and *dubh*, black.
Abermaw, *aber* and *baw* : W filthy.
Abermynwy, *aber*, and a root resembling *monadh*, moor.
Abertawy, *aber* and *tabh* : water or ocean.

Aberteifi, *aber* and *tiefi*, akin to *Taff*, *Taw*, *Tow*, a root which occurs in Tay, Tagus, Thames.

Aberavon, *aber* and *abhuinn*, river.

The question now arises as to the best and most plausible manner of accounting for the presence of *Aber* in the Topography of Wales and of the Highlands of Scotland; and for its almost entire absence from the Lowlands of Scotland where a Cymric kingdom once existed, as well as from Cornwall, which has many points of resemblance in language and race and tradition with Wales. In the face of the certainty that a large part of Scotland where no *Abers* are found intervenes between Cumberland, which in its very name perpetuates the fact that it was at one time inhabited by Cymry,—and between the Highlands where *Abers* and *Invers* are of constant occurrence, it will be vain to seek for any satisfactory explanation of the presence of so many *Abers* in Scotland in the predominance which the Cymry at one time possessed in the South of that country. Is not the conjecture more reasonable that, as Wales and the Highlands of Scotland resemble each other very closely in their mountainous character, in the ruggedness of their soil, and in the number and strength and rapidity of their streams; and as no other portion of Britain has such an uneven and rugged surface as Wales and the Highlands of Scotland, a similar term should be employed to designate the frequent confluences of streams,—a term which is not found elsewhere, and which, so far as Wales and Scotland are concerned, finds an easy explanation when the concession is made, that it was used by one and the same people in the far-off ages to describe these meetings of streams and rivers, which are common to both countries. The difficulty vanishes when it is granted that *Aber*, which is a Gaelic word, was employed by the observant Gaels of a remote age to represent these confluences which they found in Wales, and which they found in the Highlands of Scotland after they had passed over the comparatively level Lowlands. It is noteworthy that Latham is disposed to regard *Aber* as the *Abor* in the word *Aborigines*, "the locality to which it applied being either the confluence of the rivers Anio and Tiber, or the mouth of the Tiber."

Cær or *Cader*, which is the Gaelic *Cathair*, a city or fortified place, enters into many of the Topographical names of Wales, *e. g.:* Cader Idris, Cardigan, Cærnarvon, Cærmarthen, Cardiff, &c. Joyce, in his *Irish Names of Places*, (Vol. I., p. 284-5), states that "in modern

nomenclature, the word (*Cathair*) usually takes one of the two forms, *Caher* and *Cahir*, and that there are more than 300 townlands and towns whose names begin with one or the other of these two words,—all in Munster and Connaught . . . *Caher* itself is the name of more than thirty townlands, in several of which the original structures are still standing." Cathair is unmistakably present in such names as these in the Topography of Scotland : Carden, Carriden, Carlin, Carmyle, Carluke, Carlaverock. Carnervon is the name of a place in Aberdeenshire—*Cathair-an-ear-abhuinn* : the city of the East river." The contention of the advocates of the theory, that the Topography of Scotland is largely Cymric, and that *Caer* which occurs in such names as have been already cited, is an illustration of the correctness of the theory,—is altogether untenable. The very fact that *Cathair* enters so largely into the Topography of Ireland and Scotland, clearly indicates that the word is not strictly Cymric, but that it dates from a remote age when Celts, whose language was Gaelic, imposed the names which have come down to our time on similar physical peculiarities in Wales and Scotland and Ireland.

The word *Llan* which means area, yard, church, is frequently found in the Topography of Wales, *e.g.* : Llandaff, Llandeilo, Llanelly, Lampeter, &c. Joyce thus writes, (Vol. I., p. 321) : "*Lann*, in old Irish *land*, means a house or church . . . *Lann* is found in our earliest MSS., among others in those of Zeuss : it occurs also in an ancient charter . . . in the sense of house." The word *lann* occurs also in Gaelic, and has the same meaning that it has in Welsh and Irish. I am disposed to believe that between *lann* and the Gaelic word *lean*, a meadow, a green plain, there is a strong resemblance, if not an identity. Joyce admits that, in its ecclesiastical application, *lann* was borrowed from the Welsh, but contends that "when it means simply *house*, it is no doubt purely Irish and not a loan word." It is clear, therefore, that *lann* is a Gaelic word, and that it does not belong exclusively to the Cymry and to the Topography of Wales.

Loch is the term which Scottish and Irish Gaels employ to designate a *lake* or an inland sea, or arms of the sea. The Anglicised form of Loch in Ireland is *Lough*. *Llyn* is the word which occurs in the Topography of Wales to designate a lake, *e.g.* : In Cardiganshire there are Llyn Teifi, Llyn Gynon, Llyn Eiddwen. In the County of Carnarvon there are, among others, Llyn Cwlyd, (*caoilead*, narrowness), Llyn Eigian, (*aigein*, deep), Llyn Llydan, (*leathan*, broad). Llyn

is doubtless the purely *Gaelic* word, *linne*, which signifies a pool, lake, gulf. *Linn* enters into such words as Lincoln, Linn, Loch *Linne*, Roslin, *Dublin*. Though a difference obtains between the use which is made of *linne* in the Topography of Wales and the sense which it bears in the Topography of Ireland and Scotland, the word is unquestionably Gaelic, and as much entitled to that parentage as *loch*, or *cnoc*, or *amhuinn*.

The root *moin* or *moine*, a mountain, *moss*, a mossy-place, enters into *mynydd*, the Welsh word for mountain, and into the Gaelic word *monadh*. *Moin* or *monadh* enters largely into the Topography of Scotland and Ireland, *e.g.*, in the former country, Moncrieff, Monimail, Monivaird, &c., and in the latter country, Monalour, Ardmhoin.

Carn, the Gaelic word for a heap of stones, raised over the tombs of heroes,—a word which is of common occurrence in Scotland and Ireland, *e. g.*, Cairngorm, Cairndow, Carn, Carnglass, Carnlea, &c., is present in *Carned Llewelyn* and in *Carned Dafydd*, in the County of Carnarvon.

Maol, bare, *a precipitous promontory*, *Mull*, *Moyle*, which occurs in such names as the Mull of Kintyre, the Mull of Galloway, Malin Head, Rathmoyle, Lismoyle, Dunmoyle,—is present in *Moel Siabod*, *Moel Hebeg*, in the County of *Carn*arvon, and in *Mael Famman* and *Mael y-Gaer*, in Flintshire. *Drum*, the well-known Gaelic word for a *ridge* or *back*, is in Carnarvonshire. *Kinmel* (*ceann*, a head, and *meall*, a round hillock), is in Denbighshire. *Dun* appears to enter into the first syllable of Denbigh, Dinbych, *Dun*beag, the little dun or fort.

Arran, which occurs in *Arran Fowddy*, is the name of an island in Scotland and of several islands on the western coast of Ireland. *Craig y Llyn*, the rock of the pool or lake, is in Glamorganshire.

So far, therefore, as the names of mountains and ridges and hillocks in Wales are concerned, it is evident that Gaelic words are commonly to be found.

The names of various places in Wales disclose their Gaelic origin very readily. *I*, the Gaelic word for island, as in Iona, forms the last syllable of *Anglesey*.

Maeltraeth, in the same country, seems to be compounded of *Maol*, smooth or bare ; *traighe*, a beach or shore.

Penmore is *ceann*, and *mor*, large.

In *Brecknock*: *breac*, spotted, and *cnoc*, mountain, seem to enter as constituent elements.

Brynmawr, (*bryn*, hill; Irish, *bri*; Gaelic, *bruthach*, and *mawr mor*, large), signifies a large hill.

Crickhowel seems to be compounded of *creag* and *suil*, an eye. *Bangor* (*Beannchar*, pointed hill or rocks), is also the name of a place in Down, Ireland. CARREG CENNIN, in Caermarthen, is doubtless *Carraig Cheannfhionn*, the white-headed rock. *Pembroke*, (Welsh, *Penfro*), is compounded of *ceann* and *bru*, a country.

The Topography of Wales discloses its Gaelic origin very distinctly in the names of its rivers, *e. g.*, *Taff*, *Tave*, *Taw*, *Towey*, *Tow*, *Teifi*: here, are different forms of the same root, which appears also in Tagus, Tay, Thames, and which has the strongest similarity to *Tabh*, an Irish and Gaelic word, signifying *water or ocean*.

Severn : *seimh*, still, and *burn*, water.

Dee, *da*, *abh* : double water.

Dovy, *dobhaibh* ; boisterous.

Cowin, *cumhann* : narrow.

Alyn, *aluinn*, splendid ; or *al*, a stone : *abhuinn*, river.

Dwyrid, *Dur*, water ; or *duiread*, stubbornness.

Ogmore, *uisge*, *oice*, water ; and *mor*, large.

Verniew, *fearna* : alder tree.

Wye : Welsh, *Guy*, water ; *Buidhe*, yellow.

Honddu, *amhainn dubh* : black or dark river.

Conway, Comh, *con-amhainn-aimhne*: coming together of the river.

Seoint, *sinte* : extended.

Gwili, *goil*, *goileach* : boiling, raging.

Cothi, *cuthaich* : frantic.

Llwchwr, *luachair* : rushes.

Aled, *aillead* : beauty (?)

The citations which have been made from the Topography of Wales will suffice, I trust, to show conclusively, that the names of the Abers, and rivers, and forts, and hills, and lakes of Wales are of Gaelic origin ; and that the same Celtic people gave, in the unrecorded ages of the past, the names which the prominent physical features of Wales and Ireland and Scotland have preserved over the centuries, and by which, though at times in the midst of obscurity, those natural features are still wont to be described.

In the preface to his *Grammatica Celtica*, Zeuss (than whom there is no better authority), asserts "that it can by no means be established that there was a community or an identity of language between the British and the Irish, (*inter Britannos et Hibernos*), in the eighth or ninth century, or even at a much earlier date; although it is abundantly manifest that both dialects or languages have begun from one fountain." That statement of Zeuss may be construed legitimately enough in such a manner as to increase the value of the argument which can be drawn from topographical names, in favour of the theory that the Gaels preceded the Cymry in their occupation of Wales as well as of the other portions of the British Isles. May not the argument be fairly advanced, that, as the substratum of the Topography of Wales is distinctly Gaelic, and as Zeuss, as the result of his exhaustive and masterly examination of the oldest forms of the Celtic languages or dialects contends, that long before the eighth or ninth century there was no identity of language between what may be regarded as the Cymry and the Gael,—to the Celts who spoke Gaelic the honour belongs of laying the foundation of the Topography of Wales; for, although the topographical structure has many stones that are of Cymric growth, the stones that form the foundation and on which the entire structure rests, are of purely Gaelic origin, and have an indefeasible kinship with the foundations of similar structures in Scotland and Ireland.

The rapid survey which I have been able to present of the Topography of the Isle of Man and of Wales will, I trust, serve to corroborate the conclusions at which learned philologists such as Llwyd and Rhys arrived from different channels of reasoning and observation, and to strengthen the theory, if not to establish it on honest and satisfactory grounds, that the first powerful stream of Celtic immigration into Britain was Gaelic, and that the same Celts who gave names to Fintry and Bannockburn in Scotland, gave names also to Bantry and Kinsale in Ireland, to Aberavon and Carnarvon in Wales, and to Slieu Mayll and Poolvash in the Isle of Man.

A short discussion followed, in which Mr. Notman, Mr. Shaw, and Mr. Murray took part.

FOURTEENTH ORDINARY MEETING.

The Fourteenth Ordinary Meeting of the Session 1883-84, was held on Saturday, February 16th, 1884. In the absence of the President and Vice-Presidents, the chair was taken by Dr. Jos. Workman, who, later in the evening, retired on the entrance of the President.

The minutes of last meeting were read and confirmed.

Mr. Henry E. Morphy, B.A., was elected a member.

The following list of donations and exchanges received since last meeting was read :—

1. Journal of the Transactions of the Victoria Institute, to complete a set. Vols. 2, 6, 7, 8, 9, 10, bound, and Part 3, Vol. 15 ; Part 3, Vol. 16.
2. Science, Vol. 3, No. 53, Feb. 8th, 1884.
3. Transactions of the Manchester Geological Society, Part 12, Vol. 17, Sess. 1883–84.
4. Proceedings of the American Antiquarian Society, N. S., Vol. 3, Part 1.
5. Atti della Società Toscana di Scienze Naturali, residente in Pisa, Processi Verbali, Vol. 4, title-pages to do., Vols. 1 and 3.
6. Catalogue of Canadian Plants, Part 1. Polypetalæ, by John Macoun, F.R.S.C.
7. Report of Progress for 1880-81-82, of the Geological and Natural Hist. Survey of Canada. Maps to accompany the above Report.
8. Records of the Geological Survey of India, Vol. 16, Part 4, 1883.

Prof. J. Playfair McMurrich then read a paper on "The Skeleton of the Catfish," which will appear in the next fasciculus of the Proceedings of the Institute.

FIFTEENTH ORDINARY MEETING.

The fifteenth Ordinary Meeting of the Session 1883-84 was held on Saturday, February 23rd, 1884, the President in the chair.

The minutes of last meeting were read and confirmed.

The following list of donations and exchanges was read :

1. Science, Vol. 3, No. 54, February 15, 1884.
2. Bulletin of the Museum of Comparative Zoölogy at Harvard College, Vol. 11, No. 9.
3. Bulletin of the Buffalo Society of Natural Sciences, Vol. 4, No. 4.

4. The Pennsylvania Magazine of History and Biography, Vol. 7, No. 4, December, 1883.
5. Correspondenz-Blatt der deutschen Gesellschaft für Anthropologie, Ethnologie und Urgeschichte, 13 Nos., January, 1883, to January, 1884.
6. The Monthly Weather Review for January, 1884.
7. Journal of the Royal Geological Society of Ireland, Vol. 2, Part 1; Vol. 3, Part 1, 2, 3; Vol. 4, Part 2, 3; Vol. 6, Part 2.
8. The Canadian Entomologist, Vol. 15, No. 12.
9. Journal of the Anthropological Institute of G. B. and Ireland, Vol. 13, No. 3.
10. Proceedings of the Royal Geographical Society, Vol. 6, No. 2, February, 1884.

Mr. J. Gordon Mouat then read a paper entitled,

A FEW CANADIAN CLIMATES.

Of the water influences which affect the climate of Canada, that of the Pacific Ocean is by far the most extended and far-reaching. The atmospheric drift of the middle latitudes bears it across the ranges of the Rocky Mountain system and diffuses its ameliorating warmth over the vast plains of the Saskatchewan and Athabasca. The influence of the Atlantic is limited to the few hundred miles over which the eastern surface winds from the sea are drawn inland towards the cyclonic areas advancing from the west. The St. Lawrence valley shows this influence in the winter temperature, which is higher than in the central parts of the continent on similar latitudes, and in a heavier precipitation. The unequal influence of the two oceans tends to throw the meridian of greatest summer heat and winter cold—which, were these influences equal, would lie in the central part of the continent—towards the eastern coast. But here nature has provided a check in the existence of Hudson's Bay and the Great Lakes, which temper the heat of summer and mitigate the winter's cold. It is not, therefore, in the meridian of the Great Lakes that the greatest extremes are found, but westward in the valleys of the Mississippi and Red Rivers.

The influence of the Great Lakes is very marked. In the lake region of the Province of Ontario the mean of the three coldest months varies from nearly 30° Fahr. to a little less than 15°. At similar latitudes in the Mississippi valley, and at almost similar elevation above the sea, the mean temperature of these months varies from 24° to 4°. The winter isothermal of 20° skirts the north shore

of Lake Huron on the 46th parallel, descending in the Western States nearly to latitude 41°. The winter mean of 25° has in Ontario an average latitude of 43°, while in the Mississippi valley it reaches as far south as North-Western Missouri in latitude 39°. When the occasional extremes of winter cold are considered, the influence of the Great Lakes is found to be even more marked than in regard to average temperature. The lowest temperature in the past twelve years in Toronto, (lat. 43° 39′) was only −18°·4, Fahr.: Hamilton, (lat. 43°.16′) records −20°.5, and Windsor, (lat. 42° 19′) −19°.5,—while portions of the Niagara and Lake Huron districts show no temperatures lower than 12° below zero. Within shorter periods, not exceeding in any one instance eight years, the following temperatures were recorded at meteorological stations in the Mississippi and Missouri valleys:—

Cairo, Ill., lat. 37° 0′	—16°
St. Louis, Mo., lat. 38° 37′	—21.5
West Leavenworth, Kansas, 39° 20′	—29.0
Indianapolis, Ind., 39° 47′	—25.0
Lafayette, Ark	—17.0

To instance minimum temperatures in the past eight or nine years at stations further up the Mississippi valley is superfluous. Temperatures 40° below zero have been recorded at places in this valley no further north than the Canadian stations cited. During the present winter temperatures as low as—32° have been recorded in the State of Missouri. The lowest in Toronto has barely exceeded —13°. In the winter of 1874–5, the coldest on record in Ontario, when in Toronto the minimum temperature was—16°, temperatures as low as —39° were reported in Northern Illinois.

In short, the lake region of Ontario has as mild a winter mean as the Mississippi valley two hundred and fifty miles farther south, and eastward of the Rocky Mountains it is only to the south and east of a line drawn from Lake Erie to North-Western Texas that the thermometer does not occasionally fall as low as the lowest ever reached in the milder parts of the Province of Ontario.

It is interesting to notice in connection with the influence of the Great Lakes in modifying the cold of winter that the shore of Lake Michigan, opposite Chicago, has a mean winter temperature nearly four degrees higher than that of the city mentioned, and that while the pear grows with difficulty at Chicago, the much more tender

peach grows luxuriantly far northward along the eastern side of Lake Michigan, and over several thousand square miles in the Province of Ontario. The area over which the peach can be grown in this Province is nearly ten thousand square miles. It is even found to succeed on favorable soils and situations at Owen Sound, on the Georgian Bay.

If the winter cold of the Province of Ontario is mitigated by the Great Lakes, so also is the summer heat. The great central plains of the Mississippi and Missouri in summer become so heated that the mean temperature of July in Missouri and Kansas is little less than that of New Orleans in the same month. The influence of the solar rays on these great interior plains is so great that the trade winds of the Atlantic, drawn eastward into the Gulf of Mexico, are deflected northward and, affected by the prevailing eastward drift of the atmosphere, are finally carried, charged with moisture, north-eastward occasionally to the Ohio valley and the borders of the Great Lake region. Far northward, in summer, torrid influences prevail. Temperatures of 110° and upward are experienced in Dakota and Montana, and even further north across the international boundary of 49° in the Canadian valleys of the tributaries of the Missouri. But the Great Lakes interpose a buffer against the easterly drift of the interior heat. The isothermals which in winter trend southward after leaving the lake region, in summer trend north-westerly beyond Lake Michigan. The July isothermal of 74°, which is found in Ontario only in the very warmest localities of the Province, reaches a parallel two hundred miles further north in the great plains of the west. The mean temperature of 70° for the three midsummer months, which in Ontario is found rarely northward of the 43rd parallel, is reached very nearly as far north as the 49th parallel in the North-Western States and Territories. It is not until October that latitude for latitude and altitude for altitude the mean temperatures of Ontario and the Mississippi valley are equalized. The decline in temperature thenceforward till winter has set in is more rapid in the Mississippi valley than in the region of the Great Lakes which, warmed by the summer's heat, delay the advent of winter several weeks after that season is established in the central parts of the continent. The advent of spring in the lake region is also later than in the west, partly owing to the retarding effects of the lake water, which has been chilled by the winter's cold,

and partly to the greater distance from the now rapidly heating plains of the Lower Mississippi. The effect of this delay of spring is not disadvantageous, for the occurrence of the last frost damaging to vegetation is very nearly alike in point of time in the lake region and in the central parts of the continent, and in the former districts, vegetation being less advanced when that frost occurs, suffers less from its effects. The general effect of the greater liability of the Mississippi valley to intense frosts in winter, sudden changes and late frosts, is such that north of Tennessee no peach districts are found which compare, in immunity from injury through low temperatures, with the peach belts east of Lake Michigan and in the neighborhood of Lakes Erie, Ontario and Huron.

What is true of the annual and seasonal extremes of the lake region and the Western States, has its parallel in regard to the daily range of temperature. It is only once in many years that Toronto, which is fairly representative in this respect of the lake borders of Ontario, knows a range of forty degrees in any one day. The late Prof. Loomis, discussing the results of two years' records of over one hundred stations scattered over the continent north of the 35th parallel and between the Rocky Mountains and the neighborhood of the Atlantic, states that only in the Province of Ontario had he found stations at which the mercury had not ranged occasionally forty degrees in a single day. At the stations in the Mississippi valley and westward to the Rockies, greater changes than forty degrees were recorded several times in each of the two years; at several stations twenty to sixty times. Even as far south as Northern Texas sudden changes of remarkable extent are recorded by the American Signal Service. In one instance a fall from 80° to 18° within a few hours is noted; and on the 7th of September, 1881, on the northern borders of Texas, a sudden lowering of temperature proved fatal to over 300 cattle. The facts given show that in equability of climate the Province of Ontario is one of the most favoured districts in the temperate latitudes of this continent.

While the whole of the lake region of the Province of Ontario as far east as the Ottawa River experiences the modifying influence of the great lakes, the measure of that influence differs greatly according to elevation, and distance and direction from large bodies of lake water. In fact, the lake influence, while rendering the whole region more temperate than any part of the Mississippi Valley to the west-

ward, increases the differences beyond those due to latitude, so that the part of the province south of the 46th parallel presents a much greater variety of climate than any other non-mountainous district of equal area on the continent. Eastward from the Georgian Bay the effect of the great lakes in moderating heat and cold rapidly decreases, and continental conditions rather than semi-insular gradually come to prevail. Lake Ontario not lying in the direction from which the areas of low and high barometer advance on this region, has but a very limited influence. There being no large body of water to the north, such winter anti-cyclones as take a course to the Atlantic to the northward of the great lakes pour their refrigerating northern blasts down over this region.

At Ottawa the summers are hotter than at Toronto, Goderich and many other places a hundred miles or more further to the south, and though the summers over the Ottawa district are shorter than in much of the south-western part of the Province, the mean temperature of July is quite as hot as in most localities in the latter and the maximum temperature very frequently is higher than 95° in the shade; it occasionally exceeds 100° and usually is several degrees hotter than at Toronto, the eastern shore of Lake Huron, and even localities as far south as Lake Erie. The winters of Ottawa on the other hand average as low as 13° Fahr., and are much the same as at Moscow. The average minimum is about 30° below zero. Snow falls deep and the sleighing season is usually four months in length while in parts of south-western and southern Ontario, it is not as many weeks. Though the difference in latitude between Ottawa and Niagara is only about two degrees, the winters of the former place are at least as much colder than those of the latter as the winters of Niagara are colder than those of Memphis in Tennessee, eight degrees still farther south. Yet the sensible cold is not so great as this large excess might suggest; it is usually enjoyable, the atmosphere being dryer and there being more sunshine than in districts more within the influence of the lakes.

The district of Muskoka & Parry Sound, bordering on the Georgian Bay, experiences in greater measure the influence of the Georgian Bay and Lakes Huron and Superior in tempering the heat in summer and the cold in winter of winds from the western semi-circle. This influence is necessarily much more marked in winter; though the elevation of much of the district makes the apparent amelioration

less preceptible than it otherwise would be. The summers of Muskoka are cooler than those of any other part of Ontario south of the 47th parallel of latitude. But this tempering of the heat is due in large measure not so much to the influence of the Georgian Bay as to general elevation and the number of small lakes of great depth and coolness. Like the Ottawa Valley, though not to the same degree, the district is open to cold northerly winds in winter blowing outward from such centres of high pressure as move eastward to the Atlantic in high latitudes. Elevation adds to the cold of these north winds, which however are infrequent in some winters. At Huntsville (about lat. 45° 15′) in Eastern Muskoka, the temperature in January 1882 during the passage of almost the only severely cold anti-cyclone of the season, fell under a north wind to a temperature 30° lower than was reached at Toronto, and actually 47° lower than at Windsor, less than three degrees further south and little more than 280 miles distant in a direct line. In severe winters, a large part of the Georgian Bay, encumbered with islands, freezes over and the tempering effect of the lake water is thus greatly diminished.

The winters of the largo island of Manitoulin, which approaches the 46th parallel, are milder than those of Muskoka. Of the climate of the north shore of Lake Huron beyond the 46th parallel, the meteorological records are meagre. The district is protected against cold west winds in winter by Lake Superior, but is open to cold blasts from the north-west, north, and north-east. The winter isotherm of 20° skirts the coast; inland the winters are colder. The summers are said to be warmer than those of Muskoka, notwithstanding the higher latitude. Small lakes are less numerous, and are shallow and heat rapidly. Neighbourhood to the great breadth of land between Lake Huron and James' Bay—an area which sometimes becomes intensely heated in summer has probably also some effect on the summers of the district. The heat of the southerly winds is of course greatly tempered by the great length of Lake Huron stretching against them.

At a distance of from 12 to 20 miles north of the north shore of Lake Ontario extends from the Highlands of Grey in peninsular Ontario to the head of the Bay of Quinte, a ridge or watershed attaining at a few places an elevation of nearly one thousand feet above the sea, and doubtless having some effect on the climate of the basin of Lake Ontario. Eastward from the easterly termination of

this ridge the land slopes back from the lake far inland to the central heights of the watershed between the Georgian Bay and the Ottawa River. The lake has an elevation of only 234 feet (264 according to American surveys between the Atlantic and Oswego) above the sea. This comparatively low level conduces to raise the temperature of the borders of the lake. The comparatively moderate temperature of winter induced by lake influence and low level, the presence of high land to the north and west, and distance from lake water to the west, render the snowfall of the district lighter than in any other part of the lake region, with the exception of the district immediately north of Lake Erie. Sweeping over these high lands the north-west and westerly winds of winter which in passing over Lake Huron absorb considerable moisture, precipitate most of that moisture, and on regaining the low level of the Ontario basin resume almost their normal dryness. Owing to the comparative narrowness of the lake, and the fact that the winds which blow across it are not common or prevalent winds, the north shore, especially in its westerly portion derives a comparatively small proportion of its rain and snowfall from the lake, and the average annual precipitation is less than in any other part of the lake region with the exception of a limited district immediately north of Lake Erie. Towards the east end of the lake the same influences which make the climate of Ottawa extreme begin more and more to prevail; and the duration of sleighing gradually increases, till at Kingston it is nearly three months in length.

The climate of Toronto fairly represents in kind the characteristics of the north shore. At a low level and protected by the lake against the warm southerly winds, and by Lake Huron and the Georgian Bay from the cold northerly and westerly winds of winter its seasonal and daily range is comparatively small. The summer is cooler than in almost any of the larger towns in Ontario; and few have winters as mild. The mean temperature of January—about 23° for the eight years, 1874–'81, is nearly nine degrees higher than in Montreal, and is higher than in the uplands to the south-west, or than near Chicago, a degree and three-quarters farther south. The average minimum of January is —3°.1, the average minimum of the year —11°.0; the absolutely lowest in the eight years cited, —16°.0; and in the past twenty-five years —18°.4. The latter temperature is not so low as has been recorded within the same period at Louisville, Kentucky, or St. Louis, Missouri. The average duration of sleighing appears

to be between three and four weeks; in some winters there has been no sleighing whatever. An examination which I have made of the records of Toronto observatory for the past thirty Christmas days shows that only on four of these holidays, or little more than one in eight, has there been sufficient snow to permit the running of sledges, and on thirteen occasions the ground was bare. The interposition of the lake water against hot winds from southerly points of the compass greatly tends to prevent extremes of heat. The summer of Toronto is cooler than that of Montreal, the Ottawa Valley, and parts of the interior to the north, north-east and west of the city, and as cool as the eastern shore of Lake Huron. The mean temperature of July for the eight year period cited is 69°.01—which is little more than three degrees warmer than Paris, France, over five degrees farther north; and is less than two degrees for the same period warmer than Winnipeg, where though the latitude is higher by 6¼ degrees, full continental influences prevail. The freedom from warm extremes both winter and summer is more noticeable. The average maximum of January is only 46°.25. The absolute maximum (Dec. 31, 1875) of mid-winter in eight years was only 61°, while that of Galt, 56 miles westward and 520 feet higher, was 66°; that of Hamilton, 42 miles distant, but at the west end of the lake, 71°, and that of the Niagara district, 40 miles distant, nearly 80° in the shade. The average maximum of the year is only 91°.5; that of Hamilton is 96°.9, while over the Lake Erie district and over most of the inland parts of the Province as far as the Upper Ottawa, the average maximum is in most localities as high as 95°. The absolute maximum in twenty years past is only 95°.4. At Ottawa and even in Muskoka it has exceeded 100°, while at Hamilton it has reached 106°.3 in the shade. It is interesting to note in passing, that moderate as is the annual maximum at Toronto as compared with other localities in the Province, it is a little higher than at Charleston, South Carolina.

At Toronto, as, more or less, along the shores of the Great Lakes, a lake breeze by day and a land breeze by night, blow during hot, calm weather. These breezes usually do not affect the climate for more than a few miles from the shore. Inland, notwithstanding the increased elevation, the temperature is higher in the day time during the summer months than it is at Toronto.

Hamilton, only forty-two miles distant from Toronto, and only twenty-three minutes further south, has a much warmer climate, and

illustrates in an interesting manner several of the peculiar differences due to situation. Like Toronto it is exposed to the northerly winds modified by the Georgian Bay a hundred miles to the northward, but it is in a measure protected from the north-easterly winds by the intervention of Lake Ontario. More important in its bearing on the climate is the fact that the southerly and south-westerly winds which in reaching Toronto, have part of their warmth abstracted by Lake Ontario, reach Hamilton after blowing over a considerable stretch of land. Hence the latter place attains much higher temperatures in all seasons of the year than are reached on the north shore: the mean temperature is also higher. In addition to these causes which tend to increase the daily and seasonal range, the situation of the city on a low plain with a steep escarpment on the south and a range of hills across the bay on the north, tends to the existence of great daily contrasts, for in certain conditions of weather, the heat appears to accumulate in the sheltered "ravine" while in other conditions the heavy cold night air of the upland pours over the "mountain" and displacing the warm air, settles beneath it.

A remarkable instance of the effects of situation in a ravine, cutting through an extended upland, is afforded by the records of Galt on the Grand River. In 1879 the writer had charge of the meteorological station in the valley of that town. On the edge of the plateau to the west, a little more than a mile distant from the ravine station and about 180 feet higher than the later, was a second station in charge of a careful observer, Mr. Alex. Barrie. The thermometers at both stations were protected by the fence and screens approved by the meteorological service and in use at Toronto Observatory, and great care had been exercised to make the conditions of exposure similar. Here while the average daily maximum temperature was about two degrees higher at the valley station than on the plateau, the relative temperatures wore sometimes greatly reversed. On Oct. 10th 1879, the maximum at the plateau station was 90°.3, while at the valley station it was but 79°.3, eleven degrees lower. On another date in the same year the difference was still greater, the thermometer at the 9 p.m. reading on the plateau being 79°, when in the valley it was only 65°, or fourteen degrees lower. There being no station at Hamilton, other than in the valley, similar instances there of the inflow of cold air cannot be cited. But the effect of this occasional inflow is seen in the facts that while the mean temperature and

monthly maxima at Hamilton are higher than at Toronto, the monthly minima, from July to October, are very nearly the same at both places. The following tables show the average monthly maxima and minima at Hamilton and Toronto over a period of eight years (1874-81):—

AVERAGE MONTHLY MAXIMA.

	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
Hamilton.	49·7	50·9	58·2	72·0	89·0	91·0	93·9	94·0	90·3	81·6	64·3	54·9
Toronto ..	46·2	44·5	50·8	66·0	83·8	86·2	89·6	87·4	84·3	71·3	57·4	48·7

AVERAGE MONTHLY MINIMA.

Hamilton.	—0·1	—1·6	6·3	18·9	31·1	42·2	49·9	47·4	37·5	26·9	11·2	2·5
Toronto ..	—3·1	—3·3	4·0	16·6	29·0	40·4	49·2	47·8	37·6	26·3	7·5	—1·7

The average yearly maximum at Hamilton is 96°.9, the average yearly minimum -7°.4; the lowest temperature recorded in the eight years (1874–81) from which these averages are obtained was -20°.5; the highest 100°5. The absolutely highest temperature on record was 106°.3 (July, 1868), a degree of heat which has not been reached at New Orleans, or at Naples or Calcutta, in a period of at least 18 years. The average annual maximum is quite as high as at New Orleans or cities to the eastward along the Gulf of Mexico.

The mean temperature of the different months at Toronto and Hamilton for the eight-year period mentioned is as follows:—

	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
Toronto ..	22·7	22·2	28·7	40·2	54·2	62·6	69·0	67·8	60·3	47·6	35·1	26·4
Hamilton.	24·4	24·6	31·1	42·5	57·7	66·0	73·3	71·4	63·9	50·3	37·1	28·4

The mean of the year at Toronto is 44°74, and at Hamilton 47°47 or 2°73 higher. The daily range in Toronto is about 13° in January, and nearly 20° in July, while at Hamilton the figures for these months are respectively about 20° and 27°. The average daily maximum of July, at Hamilton, is above 84° in the shade, and not 79° in Toronto. In the warmest month ever recorded in Hamilton (July,

1868), the mean temperature was 80° with an average daily maximum of 93° in the shade. In Toronto the mean of the same month was 75°.8, with a mean daily maximum of only 85°.4. These contrasts sufficiently illustrate the effect of the different situation of the two cities in regard to the water of Lake Ontario.

Along the south shore of Lake Ontario, eastward to Niagara, the general features of the climate of the belt of land referred to, resemble those of Hamilton, though the thermometer does not fall so low at night as in that city. The summer heats are intense, and temperatures above 70° have even been recorded in mid-winter. The season is, over much of the district, longer than at Hamilton, where the average period between the last fall of the temperature in spring to 32°, and the first descent in autumn to the freezing point, was for three years (1878-80), 186 days. The measure of protection afforded by Lake Ontario from the winds from northerly points of the compass increases, and the mean temperature of winter rises. Lake Erie also affords a measure of protection against the cold which in winters unusually severe in the Western States sometimes accompanies southwesterly winds. At Niagara the mean of winter is several degrees higher than at Hamilton, and nearly as high as at New York, and the average minimum of the year is little, if at all, below zero. The heat and duration of summer and the comparative mildness of winter make the district peculiarly well adapted to fruit growing. The peach-orchard area of the district is very large, and vineyards averaging four to five tons of grapes to the acre are numerous. The sweet potato and the peanut flourish in a degree unsurpassed in any other district in the province. The mulberry grows luxuriantly. The pseudo-papaw, and the tulip tree, *Liriodendron tulipfera*, grow wild in the woods and attain large proportions. At Niagara the writer has found fig-trees heavily laden with fruit, growing in the open air with but little winter protection; and the soft-shelled almond, though of course but little cultivated, with slight winter protection, produces fruit equal to that of the common almond of commerce.

The north shore of Lake Erie, like the north shore of Lake Ontario, and for similar reasons, is marked by a tendency to the avoidance of great extremes of heat, though owing to latitude and the shallowness, and therefore greater warmth, of the water, the hot extremes of the summer months, and the mean temperature are higher than on the

north shore of Ontario. In exceptionally severe winters, ice forms to a greater extent on the bays and indentations of Lake Erie than along the Lake Ontario coast, and though the mean temperature on the north shore of Erie is higher than on the same shore of Ontario. the winter maximum in such seasons is no greater than at Toronto. The snow of winter is light, and usually lies but a short time, even in winters when around Buffalo the depth is great and the sleighing of long duration.

The eastern shore of Lake Huron has a climate differing in several important particulars from the Canadian shores of Lakes Erie and Ontario, and illustrating more than these lakes the peculiar effect of a large body of water interposed against the prevailing westerly winds. The winters are nearly two degrees warmer than at Toronto, and are as mild as those of Hamilton, as free from cold extremes as at Niagara, and from warm extremes as at Toronto, yet the moisture of the lake winds makes the sensible cold appear greater than in the interior or in the Niagara District. Spring is retarded by the lake influence, and the mean of that season at Goderich is no higher than at Toronto; but on the other hand the autumn is several degrees warmer: summer is as cool as at Toronto, and comparatively free from very high temperatures. Goderich, lat. 43° 25′; altitude, 728 feet, has a mean temperature for the year a little higher than Toronto. Zero temperatures, and temperatures above 90° are rare; and the contrast in this respect with the Michigan shore opposite, is very marked. The climate is one of the most equable of the whole lake region, and surpasses in this respect almost every other district in the middle latitudes of the continent. The peach grows far north, and even on the Georgian Bay. Towards the southern part of the district, peach-growing is an important industry. Owing to the moisture of the lake winds, this shore is not so well adapted to the vine as the ordinary or low levels of peninsular Ontario. The rainfall and snowfall are both heavy, for to the rainfall brought by cyclonic areas, there is added the moisture gathered by westerly winds from the lake. The north-westerly winds, normally intensely dry, gather a large amount of moisture from the lake, and in winter when the land is chilled, this moisture is precipitated in snow flurries to a considerable depth. The interior of peninsular Ontario varies greatly in elevation, rising slowly and gradually from Lake Erie; more rapidly from Lake Huron and still more abruptly from the Georgian Bay, up to the

Highlands of Grey, where an elevation of 1,700 feet above the sea is attained. Consequently, considerable differences in climate exist in this interior. On the Highlands of Grey, and on the Lake Huron slope the snowfall is often excessively heavy, and the snow lies several feet in depth, when in some districts of the Province the ground is bare. Sleighing usually lasts for three months or more on the highest levels. Of the annual precipitation of this part of the interior, there are but few records, and these cover but a very short period. There is reason, however, to think that the annual precipitation in some localities, as in Muskoka, exceeds 50 inches, that is, amounts to nearly twice the precipitation of the dryest localities of the Province. The explanation of this heavy precipitation has already been sufficiently indicated.

The winter temperature of the central watershed, owing to great elevation, is cold, averaging in some localities below 20°. The extremes of cold, too, are great, though on these, as on the winter mean, the surrounding lakes exercise a moderating influence, and the temperature usually does not fall so low as at Ottawa or as in the Western States at even lower levels and much lower latitudes.

The difference in mean summer temperature between the lake shore and the highest land of the interior, is not great when the difference in altitude is considered. The mean of July, at the highest points, is about 65° and the maximum heat is about as high as on the Lake Huron shore. The degree of heat attained is due, in a large measure, to the extent of unbroken land to the south and southwest. At Owen Sound on the south shore of the Georgian Bay, so much does this large land area in the direction of the warm winds affect the climate, temperatures as high as 95° have been reported in the month of May. At elevations of 1,000 to 1,200 feet, the mean of summer is nearly as high as at Toronto, and the daily and yearly maxima are higher. The difference from the lake coasts and lower levels is chiefly in the existence of a greater daily and seasonal range on the high land and a shorter period of exemption from early and late frosts. On the long slope towards Lakes Erie and St. Clair, the mean temperature of all seasons gradually rises, and at some distance inland the mean temperature of summer exceeds that of the Erie coast by several degrees, and almost equals that of the very warmest localities of the Province. In extremes of warmth, both summer and winter, the temperatures are higher than in most localities near the

lakes. At Galt, lat. 43° 20′, altitude 870 feet, the mercury usually rises to 95°, and has exceeded 100°. London sometimes records a higher July mean than even Hamilton or Windsor. At Zurich, towards Lake Huron, 103° was reported in 1881. Perhaps as forcible an illustration of the tendency of the interior to develope extreme heat as can be given, is in the fact that while in 1881, at Brantford, lat. 43°10′, altitude 720 feet, there were in May 7 days, in July 21 days, in August 16 days, and in September 7 days—51 in all—on which the mercury rose above 90° in the shade, and while the highest temperature was 99°, in Toronto there were but five days, in all, on which a temperature above 90° was reached, and the very highest was only 92°.7. Towards the south-western portion of this inland district, the absence of lake water to the south-west, between the foot of Lake Huron and the head of Lake Erie, fully admits the south-west wind, which is usually warm, and winter temperatures comparatively high are often recorded. An indication of the general climate of this Lake Erie slope is that the peach is grown, on suitable soils, to an elevation of about 1,000 feet above the sea.

In much of the interior of peninsular Ontario, thunder storms are numerous and more severe than on the north shore of Lake Ontario. Tornadoes also occur more frequently, though they are not so violent nor so frequent as in equal areas in Ohio, Indiana and the Central Western States. The snowfall of the Lake Erie slope rapidly diminishes as the distance from Lake Huron increases. North-west winds which near Lake Huron and in the highlands of Grey, bring several inches of snow in a single day are usually snowless over the southern half of the peninsula. At Galt the average duration of sleighing is not more than six weeks; southward and south-westward the period decreases to a few days. The advent of spring is one or two weeks earlier over much of the southern part of the district, than at Toronto, and winter-wheat harvest is almost as much earlier. Harvest usually commences in the beginning of July and has been known to begin in the end of June, as far northeast as Galt, and about the 15th of June a short distance north of Lake Erie.

The climate of Windsor on the Detroit River, lat. 42° 19′, altitude 604 feet, is fairly representative of the climate of the extreme south western part of Ontario. Immediately to the north is Lake St. Clair, and not far beyond that lake, Lake Huron, affording protection from the cold north winds of anti-cyclones passing eastward north

of the great lakes. To the south at no great distance is Lake Erie affording only a slight protection against the warmth of the south wind in winter. But against the cold in winter of westerly and north-westerly winds there is no shelter except such as the distant Lakes Michigan and Superior supply, and against the warmth generally, and in some winters the excessive cold, of the south-west wind there is little or no protection. Lake St. Clair is shallow, and in severe winters freezes over, and loses its protective influence, and both it and the very shallow westerly end of Lake Erie become in summer greatly heated, and not only lose the protective influence against extreme heat which lake-water generally exercises, but even at times, and especially in autumn, increase the heat. The extreme south-west has therefore a climate, on the average of the year warmer than almost any other part of the Province, but more variable also than most of peninsular Ontario.

The winter mean is the same as that of Hamilton, but with monthly extremes of heat and cold greater than in that city. The average yearly minimum is about the same as at Toronto. Owing to the great differences in the temperature of different winters in the Western and South-Western States, and the consequently great differences in the temperature of south-westerly winds in different winters, the temperature of the Windsor winters differs very much. In eight years (1874-81) the coldest January was 14°.7 which is lower than any January in the same period at Hamilton or Toronto, or eighty miles northward at Goderich. The warmest January on the other hand was 36°.2, or considerably higher than any at Toronto or Hamilton. December means varied from 18°7 to 38°9 ; March from 26°.6 to 41°.7 ; April from 37°.9 to 54°.2. Though the midsummer months show little difference in their mean temperature in different years, October means ranged from 46°.6 to 58°.9 ; May from 57°.2 to 65°.5, and September from 59°.0 to 72°.2 ; the last higher than any Toronto July in the same period.

The mean of the summer months is almost the same at Windsor as at Hamilton. In autumn, with the exception of the month of October, the two places are alike in mean temperature. It is the temperature of the spring and early summer that makes the mean of the year at Windsor (48°49) one degree warmer than the annual mean at Hamilton. April at Hamilton has a mean of 42°.5 ; at Windsor 45°.25 ; in May the figures are respectively 57°.7 and 60°.8 ; in

June Hamilton averages 66°.0 and Windsor 67°.85. The earlier springs of Windsor are due in part to latitude, in part to greater nearness to the rapidly advancing heat of the south-west, and in part to the fact that easterly winds which prevail in spring reach Hamilton from the deep, winter-chilled lake, and Windsor from the warmer land of Essex and Kent.

The following table shows the mean temperature of each month, the average monthly maxima and average monthly minima at Windsor, for the eight year period (1874-81.)

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Mean	24·1	24·7	32·4	45·3	60·8	67·8	73·4	71·4	63·8	51·6	37·1	28·4
Mean max.	50·0	53·5	61·8	77·3	88·9	91·7	95·1	93·5	90·5	81·2	64·5	53·3
Mean min.	—3·0	—0·6	9·4	18·8	30·0	47·3	51·4	48·3	36·8	25·0	10·4	0·0

The mean of the year is 48°.49 ; the mean maximum 96°.25, (very nearly the same as at Hamilton) and the mean minimum,—10°.75 or 3°.4 lower than at Hamilton, and almost the same as at Toronto 2¼ degrees farther north. The absolutely highest temperature in the eight years referred to was 100°.6 (Sep., 1881) : the absolutely lowest —19°.5.

In the four coldest months the maxima were as follows :—Dec. 68°.3 ; Jan., 66°.9 ; Feb. 63°.4 ; March, 77°.4. The contrast with Toronto goes to show the effect of Lake Ontario in protecting against unseasonable temperatures. There the absolute maxima for those months were Dec., 61°.1 ; Jan., 57°.5 ; Feb., 51°.6 ; March, 58°4. Absence of lake-water to the west renders the precipitation small compared with the adjoining Huron district. The snowfall is light, and the general temperature of winter, and particularly the warm extremes, reduces the average period of sleighing to a few days. The fruits and flora generally are the same as in the Niagara district. The vineyards are very productive, averaging in good soils five tons of grapes, and nearly 700 gallons of wine (first drawing) to the acre—a yield probably unsurpassed either in California or in Europe.

The southernmost part of Ontario and of Canada, Pelee Island, a township of 17 square miles (lat. 41° 40′ to 41° 50′—further south than Rome), has a climate peculiarly interesting. The island lies

almost midway between Sandusky, Ohio, 20 miles distant, and Leamington, Ont., and with Kelly's, an Ohioan island, six miles to the southward, and the peninsula of Point Pelee to the northward, marks the dividing line between the very shallow and island-dotted western extremity of Lake Erie, and the larger, deeper and unbroken area of the lake to the eastward. This peculiar position produces remarkable climatic effects. The water to the westward is generally not more than forty feet in depth, and under the hot summer sun becomes so heated that temperatures above 80° are sometimes registered at lake bottom in the habours along the neighbouring coasts. This high temperature not only tends to increase the average heat and length of summer, which here is almost as warm as at Cincinnati, but increases the warmth and length of autumn—which also is as warm and free from frosts as on the Ohio River—and reduces the difference between day and night temperatures to almost tropical smallness. Another effect, a physician on the island informs the writer, is that what corresponds with the nightly land breeze of the lake coasts in hot, calm weather, here blows not from the land, but from the deeper and cooler lake water to the eastward, into the heated western end of the lake. The effects in winter of the surrounding shallow water, vary with the severity of the seasons. In the milder winters the usual effects of water surroundings are experienced in a small daily and seasonal range. In severe winters the shallow archipelago of the western end of Lake Erie is encumbered with ice and sometimes freezes over, and Pelee partakes in greater measure of the continental character of the winter of the neighbouring mainland.

An examination of the records of the meteorological station on the island for a period of three and a half years bears out the deductions which otherwise could be made from the peculiar situation of Pelee.* The figures are interesting. The mean temperature, and mean monthly maxima and minima are as follows :

* The records, which through the courtesy of the Superintendent of the Meteorological Service, were furnished the writer, embrace the period between February 1st, 1879, and August 31st, 1882. The records for May, October and November, 1879, and April and November, 1880, are incomplete or wholly wanting. The mean temperature for these missing months has been approximated by the writer after careful examinatien of the records of Windsor and Sandusky, what is believed to be due allowance having been made for the peculiarities of the Pelee climate. The hours of observation were 7 a.m. and 2 and 9 p.m. The mean temperature is found by adding together the readings at the first two hours, and twice the 9 p.m. reading, and dividing the sum by 4. The maximum and minimum temperatures given are those of the

	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
Mean	26·2	27·4	32·5	41·7	59·2	67·1	73·5	72·9	66·3	56 4	38·7	29·1
Mean max.	47·7	54 3	54·5	65 0	85·3	91·0	95 0	91·5	90·7	72·0	62·0	49·7
Mean min.	6·7	7·0	18·7	18·7	40·3	51·3	61·5	59·7	49·5	37·5	28·0	9·9

The mean temperature of the year is 49°·25: did the record extend over the eight years which have been used for the averages of Toronto, Hamilton and Windsor, it would probably appear a small fraction of a degree lower.

The coldest January averaged 16°.5, or 0°.7 higher than the same month at Windsor, while the warmest, (34°.8) was 1°.4 colder. The absolutely lowest temperature (—12°) occurred when the west end of the lake was covered with ice and was 5°.4 lower than at Windsor. The occurrence of lower temperatures than at Windsor during the same severe season suggests that the effect of a neighboring area of ice in extremely cold weather, is more favourable to the development of cold than is the vicinity of an unbroken land area, an explanation which may find additional illustration along the eastern side of the Georgian Bay. In mild winters the low extremes are higher at Pelee than at Windsor. In January 1880 the minimum at that town was 19°, while at Pelee it was only 25°. In the other months of the same winter the difference in favour of Pelee was from 4°.5 to 10°.5. The absolutely highest temperatures in the winter months were: Dec. 57°, Jan. 55°, Feb. 63°, March 60°. The extraordinary smallness of the mean daily range in winter is shown by a comparison between the averages of the 7 a.m. and the 2 p.m. readings. The average difference in Dec. is only 2°.2, in Jan. 3°.3, Feb. 6°.4, and March 5°.4. In December 1881 the average temperature was 34°.7, but the 2 p.m. reading was only 36°.1, and the 7 a. m. 34°.5, a total range of only 1°.6, between hours which represent, at this season

hours of observation only, but a careful consideration of the facts as to cloudiness, direction of wind, &c., at the times of their occurrence, and for some time before and after, leads to the conclusion that in many instances they represent within a fraction of a degree the true max. or min., as the case may be, and that in few instances can the highest or lowest temperatures have differed more than one or two degrees from these quantities as taken from hours of observation alone. Where the mean temperature of the month is not derived from the original records no attempt has been made at supplying maximum and minimum, or averages other than for mean temperature. The mean maximum and mean minimum of November is consequently derived from but one month, that of October from only two, those of January, February, April and May from three, and the remaining months of the year from four.

especially, very nearly the extremes of the day. The average daily range in January furnishes an interesting contrast with the range in the same month at Toronto and Hamilton.

April at Pelee is almost as cold as at Toronto, and is more than 3° colder than at Windsor, thirty miles further north. The effect of the cold lake water is shown in the fact that the highest maximum in this month was 82.°9, (April 1881) while in Pelee it was but 68°. Yet the last frost of the season is several weeks later at Windsor than in Pelee, where it occurs about the middle of April. In May, Pelee almost regains the normal temperature of the districts on the neighboring mainland : temperatures above 90° are recorded and frosts are known only in exceptional years.

The summers are hot and steady. In only one June in four years was a lower reading than 50° recorded. In July and August only once in the same period was there a lower reading than 60°. The daily range in summer is much greater than in winter but still not half so great as at most stations on the mainland of Ontario. The range between 7 a.m. and 2 p.m. for June is 8°.4, July 8°.6, Aug. 7°.5. The daily range above the mean temperature is in summer twice as high, as the range below the mean, the nights maintaining an almost even temperature of about 70° in July and August, while the day temperature rises in July to at least 80°. This daily maximum is not so high as that of some parts of the Ottawa Valley, and is much below the daily maximum of Hamilton and Windsor, where however the night temperatures fall considerably lower than at Pelee.

Intensely tropical weather frequently prevails for days together, when, though the mercury does not rise any higher than on the mainland, it does not fall at night below 80°. In the steaming atmosphere of this shallow lake such days must be very oppressive. The following are instances from the records :

	7 a.m.	2 p.m.	9 p.m.
July	86°	96°	83°
Aug	83°	95°	85°
Sept	82°	98°	84°

September, in regard to heat, is properly a summer month, its mean being higher than that of a Paris July, and little lower than that of a Toronto August. In 1881 the mean was 72°.9, with a minimum temperature of only 58°.

October averages 56°.4, nearly ten degrees warmer than at Toronto, and quite as warm as in the Ohio Valley. November prolongs the balmy, hazy weather which persists here for months, and it is not till about the 12th of the month that the first hoar frost of the season usually occurs on the warmer soils of the island.

In winter sleighing is rare. The rainfall in the warmer months is comparatively light, owing to the high temperature above the shallow surrounding waters checking condensation.

The mean period in which the mercury does not fall to 36°—the average point at which hoar frost here occurs—is nearly seven months in length, or quite as long as at Memphis, Tennessee, and much longer than throughout most of Ohio and Indiana. It extends from April 14th to Nov. 12th. The great length of the season, combined with the long steady heat admits of the full maturing of cotton, which at one Pelee farm visited by the writer, has been grown for many years without any special care either to secure protection or early maturity. Climatic conditions are more favorable to the cultivation of the Catawba grape on Pelee and adjacent islands than in any other part of America. Including the mainland on both sides of the lake, this district is the most famous wine district on the continent, with the exception of a small area in California, where however the yield per acre is not greater than here. On the islands alone, millions of gallons of wine are produced, and the area in vineyards can be greatly extended. The grape crop is never injured by frosts, and conditions in regard to moisture are more favourable to avoidance of loss through mildew than in the Ohio Valley, which formerly was the chief centre on this continent of the production of Catawba wine.

To find European parallels to the various climates of Ontario which have been described, would be no easy task Individual districts will find winter parallels in the Crimea, on the banks of the Danube, and at Berlin on the one hand, and on the other at St. Petersburg, Moscow, Astrachan and in Central Russia. The summers of parts of the Province are paralleled in those of Lisbon, Northern Spain and Italy, Southern France, the lower Danube and Constantinople, or in the cool summers of Paris and Berlin. The Ottawa Valley and the central and inland parts of the Province of Ontario have summers like those of Vienna. Toronto at any season of the year differs but little in temperature from Bucharest. The month of July at Hamilton and Windsor is almost as warm as at Oran, in Algiers, and but

little cooler than at Jerusalem, in Syria. In general, it may be said that a line from the Danube through Bucharest to Moscow would furnish parallels to the climates along a line from Windsor north-easterly to Pembroke, on the Ottawa—though the summers of the latter place are warmer than those of Moscow.

By a British standard the summers of much of the Province may be considered long. May in south-western Ontario is warmer than July at Edinburgh. September is warmer than July at London, and warmer than September at Vienna. The vine, maize and sorghum fully mature in most parts of the Province south of the 46th parallel, and in not a few districts yield as abundantly as in any part of America or Europe. The limitations on the cultivation of the vegetals of similar latitudes in Europe is more in the intensity of the winter frosts than in the lack of a sufficiently long or warm summer.

NOTE.

The length and heat of Ontario summers contrasted with those of other places in Canada, and various places in Europe, may be seen by a glance over the following table. The means for Toronto, Hamilton, Windsor and Winnipeg are derived from the annual records of the Canadian Meteorological Service for eight years (1874-81); those for Montreal from same records for six years (1875-80); those for Pelee, from C. M. S. station reports for three and a half years. The averages for European Stations are quoted from Blodgett's "American Climatology," and are for periods, with few exceptions, longer than eight years.

MONTHLY MEANS OF CANADIAN SUMMERS.

	MAY.	JUNE.	JULY.	AUG.	SEPT.
Toronto	54°·2	62°·6	69°·0	67°·8	60°·8
Hamilton	57·6	66·0	73·4	71·3	63·9
Windsor	60·8	67·9	73·4	71·4	63·8
Pelee	59 2	67·1	73·5	72·9	66·3
Montreal, Que.	55·0	65·0	69·8	68·1	59·0
Winnipeg, Man.	52·9	61·8	67·3	64·1	51·9

MONTHLY MEANS OF EUROPEAN SUMMERS.

Edinburgh	50·3	56·0	58·7	56·8	53·4
Aberdeen	52·3	56·7	58·8	58·0	54·6
York	54·5	59·2	62·0	61·1	55·7
London	55·8	58·7	61·7	58·9	56·6
Dublin	54·4	60·2	61·5	61·4	56·5
Paris	58·1	62·7	65·6	65·3	60·1
Rochelle	59·4	67·5	69·0	66·5	62·4
Vevay	58·2	64·4	68·4	64·4	59·6
Munich	57·6	62·1	64·7	64·1	58·1
Berlin	56·5	63·3	65·8	64·4	58·4
Konigsberg	52·0	57·4	62·6	61·7	53·6
Vienna	62·1	67·5	70·7	70·0	61·9
Bucharest	56·3	62·5	68·1	65·2	58·3

The following members took part in the discussion which followed: The President, Dr. Barclay, Dr. Jos. Workman, Dr. O'Reilly, Mr. John Notman and Mr. David Boyle.

SIXTEENTH ORDINARY MEETING.

The Sixteenth Ordinary Meeting of the Session 1883-84 was held on Saturday, March 1st, 1884, the Third Vice-President, Dr. Geo. Kennedy, in the chair.

The minutes of last meeting were read and confirmed.

The following list of donations and exchanges was read:

1. Science, Vol. 3, No. 55, for Feb. 22nd, 1884.
2. Memoirs of the Boston Society of Natural History, Vol. 3, No. 8, on the development of Œcanthus Niveus and its Parasite, Teleas, by Howard Ayres.
3. Harvard University Bulletin, Vol. 3, No. 4, for January, 1884.
4. Historical Collections of the Essex Institute. Vol. 20, Nos. 10, 11, 12, for Oct., Nov. and Dec., 1883.

Dr. P. H. Bryce read a paper entitled, "Some Factors in the Malaria Problem."

The reader of the paper explained that he proposed reading extracts of a Report made upon malaria, prevalent in the lower district of the Grand River, under the direction of the Provincial Board of Health in September last.

After stating briefly the characters of the district regarding the nature of the soil and the underlying geological formations, in which he stated that coniferous strata are overlaid by Erie clays, and that the Saugeen clays overlie these, Dr. Bryce went on to explain how that, since the time of the building of the dams on the river for the purpose of supplying water by a feeder to the Welland Canal, malaria had been very prevalent up to the present. This he showed by the statements of old settlers and medical men, regarding that in past years, and by the tabulated reports of disease made by medical correspondents of the Board during the last year. After explaining the results upon the low-lying flats along the river of the damming back of the waters, the writer stated that there were three distinct elements of the problem, namely, the conditions of the soil, the ground-water and the air. Assuming that the various causes which it

has been assumed cause malaria are all much less satisfactory than the germ theory, in which some bacterial organism, e. g., *Bacillus Malariæ*, is supposed to be the immediate cause, Dr. Bryce went into a discussion of how the local physical conditions might favour the free development of these germs, as it is well known that vegetable organic matter in a decaying state forms a favourite *nidus* for the development of bacteria of every kind. This material is largely present in some of the overflowed lands along the river, but free development of organic life in such depends upon the amount of water present in the soil. This necessarily varies with the dryness of the season and with the height of the river-water. This last point introduced the subject of its probable effects upon the ground-water of the low lands along the river. Through the denuded nature of the river-valley, the subsoil water of the neighboring higher lands naturally drain toward the valley along impervious beds of clay, and in some parts along the surface of the underlying rocks. This is seen in some parts in the presence of flowing wells. But, according to Miquel's experiments, it is not enough for the prevalence of germs in the air that they be developed in the soil. It is necessary that the upper layers of soil dry out sufficiently to allow the winds to carry these freely into the air. Further, their free development in the soil depends largely upon the amount of air in the soil, or oxygen. This it is clear must vary with the height of the ground-water, since as the water rises or falls the air must be less or more in the interstices of the soil. Hence, though ground-water conditions the amount of air in the soil, it is after all the oxygen of the air which determines the development of germs. But the next point in this connection is the fact that, as the temperature of the soil varies greatly from that of the contiguous atmosphere, especially during the warm summer weather, it follows that there is a regular circulation of ground air, new oxygen being constantly taken into the soil to supply the conditions of free zymotic development; and further, that this circulation probably serves to some extent as a vehicle for carrying the germs of the soil into the air. Upward currents of air during the day prevent an accumulation of atmospheric particles near the earth, and, on the other hand, the upper colder strata of air descending toward and after sundown, and especially in calm weather, cause accumulations near the earth of germs which have been carried up during the day. Hence, along with the increased humidity, is probably explained why night air is proportionately more mala-

rious than day air. The influence of winds in greatly increasing the number of particles and germs in the air was also discussed and in this way, the writer explained, it was probable that the germs of malaria were laterally disseminated, and how they would tend so to increase each succeeding year as they found new centres of development. Hence it was apparent that forests, both mechanically, by breaking the force of winds, by keeping the air moist, by preventing extreme differences between day and night temperature, and by preventing undue drying out of the soil, would act favourably in preventing the wide-spread prevalence of malaria.

Discussing the matter of the influence of cold in causing malaria, the writer gave a number of selected experiments concerning the rapid decrease of body temperature under different physical surroundings, as temperature, wind and moisture.

He finally showed how drainage and the planting of forest trees would serve to lessen the conditions of soil favourable for the development of *Bacillus Malariæ*, the assumed immediate cause of the disease.

A discussion ensued in which Mr. W. Houston, Prof. J. P. McMurrich, Mr. Livingstone, Dr. Oldright, Mr. J. Notman, Dr. Bryce and the Chairman took part.

SEVENTEENTH ORDINARY MEETING.

The Seventeenth Ordinary Meeting of the Session 1883-84 was held on Saturday, March 8th, the President in the chair.

The minutes of last meeting were read and confirmed,

The following list of donations and exchanges was read :

1. Science Record, Vol. 2, No. 4. Feb. 15th, 1884.
2. Science, Vol. 3, No. 56, Feb. 29th, 1884.
3. The Canadian Practitioner for March, 1884.
4. Journal of the Franklin Institute, for March, 1884.
5. Journal of the Royal Microscopical Society, Series 2, Vol. 4, Part 1, for February, 1882.
6. The Canadian Entomologist, Vol. 16, No. 1, January, 1884.
7. Proceedings of the Royal Society of London, Vols. 31, 32, 33, 34, 35, and Part 1, Vol. 36, containing Nos. 206 to 228 inclusive, from March 24th, 1881, to Nov. 30, 1883.

A paper was then read by Mr. Wm. Houston on "Old English Spelling and Pronunciation."

In dealing with the subject, Mr. Houston dwelt for sometime on the changes which have taken place in the pronunciation of English words since Anglo-Saxon, in its various dialects, was the spoken language of the common people of England. The principal authority cited was Mr. A. J. Ellis, who has established by a wide induction from a variety of sources a considerable number of indisputable conclusions, though there are still many points left doubtful. As pronunciation changed, spelling should have changed also, and, as a matter of fact, it did so to some extent before the invention of printing, and to a less extent since; but the growing tendency of modern times is to allow the printers, to whom uniform spelling is a matter of great convenience, to fix the forms of words, not only absolutely but arbitrarily. The reader of the paper cited numerous instances of old spelling from Milton back to Chaucer to show (1) that spelling in Old English was more phonetic, and therefore better than now; (2) that spelling varied with pronunciation in the use of words by the same writer; and (3) that so far from adherence to a uniform system of spelling being regarded as a chief criterion of scholarship, old writers allowed themselves a great degree of latitude in their modes of spelling words. Spenser is an extreme instance of this free and easy view of orthography, for it is not uncommon to find him spelling the same word three or four different ways on the same page. In conclusion, Mr. Houston contended for greater freedom in orthography, not in the interest of diversity, but in the interest of simplicity of spelling.

The following gentleman took part in the discussion which followed: Dr. Workman, Dr. Bryce, Mr. J. Howard Hunter, Mr. D. Boyle, Mr. Murray, Mr. Shaw, Mr. Notman, Mr. Keys, Mr. Livingstone, Mr. Macdougall.

EIGHTEENTH ORDINARY MEETING.

The Eighteenth Ordinary Meeting of the Session 1883-84 was held on Saturday, March 15th, the Third Vice-President Dr. George Kennedy in the chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were elected members of the Institute:

T. C. L Armstrong, M. A., LL.B., Henry William Eddis, Esq., and Frank Arnoldi, Esq., Barrister.

The following list of donations and exchanges was read:—

1. Science, Vol. 3, No. 57, March 7, 1884.
2. The Canadian Record of Natural History and Geology, Vol. 1, No. 1, Montreal, 1884.
3. Transactions of the Ottawa Field Naturalists' Club, No. 4.
4. Annual Report of the Library Commissioners and Libarian of the Legislative Library of Nova Scotia, and the Librarian of the Nova Scotia Historical Society for the year 1883.
5. Transactions of the Royal Geological Society of Cornwall, Vol. 10, Part 6.
6. Annuaire de 1884, de la Société des Ingénieurs Civils, 37e. Année.
7. Appleton's Literary Bulletin, March, 1884.

PURCHASE.—38 Nos. of the Journal of the Franklin Institute of various years, to complete a set.

Mr. T. P. Hall, B. A., Fellow of University College, read a paper on "Photography and the Chemical Action of Light," illustrated by diagrams and apparatus.

After reviewing the history of photography, Mr. Hall showed the scientific value of this art, in leading to a more complete knowledge of the nature of radiant energy. The action of different parts of the spectrum upon various substances was explained in connection with wave-lengths and atomic vibrations, and the direction of future advances in photography indicated. The relation between transparency to certain rays and chemical composition, fluorescence, phosphorescence, colour-blindness, and other interesting subjects in this connection were discussed and illustrated. The following is an extract: "To make photographs which shall appear accurate to us we require a compound sensitive to the same rays and in the same relative degree as our eyes are. . . . Since, besides being deaf to an unknown variety of sounds, we are blind to nine-tenths of the light of the spectrum, it becomes a question of interest whether the

lower animals are more or less blind than we. From his experiments on ants, Sir John Lubbock concludes that they are nearly or quite blind to red and yellow rays, and sensitive to green, blue, violet and ultra-violet rays. A photograph taken with silver chloride, which is very imperfect to us because the red and yellow rays are not represented, and violet and ultra-violet appear very bright, would therefore to the critical eye of an ant appear quite correct."

Dr. Bryce and Mr. VanderSmissen made remarks on the subject, after the reading of the paper.

NINETEENTH ORDINARY MEETING.

The Nineteenth Ordinary Meeting of the Session 1883-84 was held on Saturday, March 22nd, the President in the chair.

The minutes of last meeting were read and confirmed.

The following list of donations and exchanges was read :

1. Selected Papers of the Rensselaer Society of Engineers, Vol. 1, No. 1, January, 1884.
2. Transactions of the Manchester Geological Society, Vol. 17, Part 13.
3. Weather Review for February, 1884.
4. List of Fellows 1884, Royal Microscopical Society.
5. Science, Vol. 3, No. 58, March 14th, 1884.
6. Proceedings of the Royal Geographical Society, Vol. 6, No. 3, March, 1884.

Mr. W. J. Loudon, B. A., read a paper on the "Radiometer," illustrated by experiments.

The following members made observations on the subjcct: Mr. H. S. Howland, jun., Mr. Murray, Mr. Macdougall, Mr. McKenzie, Mr. Livingstone and Dr. Bryce.

TWENTIETH ORDINARY MEETING

The Twentieth Ordinary Meeting of the Session 1883-84 was held on Saturday, March 29th, the President in the Chair.

The minutes of last meeting were read and confirmed.

The following list of donations and exchanges received since last meeting, was read :

1. Science, Vol. 3, No. 59, March 21, 1884.
2. Life and Work of Darwin, by George Acheson, M. A.
3. Trübner's American, European and Oriental Literary Record, Vol. 4, Nos. 11, 12.
4. Transactions of the Oneida Historical Society at Utica, 1881.
5. Science Record, Vol. 2, No. 5, March 15, 1884.
6. Proceedings and Transactions of the Royal Society of Canada for the years 1882 and 1883. Vol. 1, Montreal, 1883.

Mr. Henry Brock then read a paper on

THE UPPER NIAGARA RIVER.

The Border land has long been a theme for novelist and poet, and pen-pictures of the stirring scenes amongst the Grampians, the plateaux and peaks of the Tyrol, and along the vine-clad banks of the Rhine have been depicted with the fervour of enthusiasm by the many lovers of what has tended towards forming the national character of their native land.

The border land of Canada has been the scene of many a heroic contest. And from Frontenac's struggles against the Mohawk and Iroquois, until the days of Earle's Hill and Limeridge, the Canadian, whether of French or English descent, has proved true to his native land. My intention this evening is to touch upon but a small portion of this interesting subject. Leaving out the country bordering on Memphremagog and Champlain, the noble St. Lawrence, and the clear flowing Detroit and St. Clair, I must content myself if I can bring before you a few reminiscences interesting to the antiquarian or historian of the Niagara Frontier, and particularly that portion of it which is commonly known as the "Upper Niagara River." Commencing at a point where 60 years ago a village hamlet stood with a few hundreds of a population, but where now 200,000 busy people are continuing the struggle for existence in the great city of Buffalo, and flowing in a north-westerly direction from Lake Erie, the Niagara River separates Canada from the United States. On the Canadian side of the river, just opposite Buffalo, are the remains of what was formerly Fort Erie. The fort is entirely dismantled, and is marked only by a few earthen ramparts fast settling down to the ordinary level. It was at this place that the Fenians of '66 crossed,

although from the swiftness of the current of the river just below this point, which sweeps on at the rate of 10 miles an hour, and the width of the river, a few ordinary guns in their former embrasures at Fort Erie would prevent any such undisciplined raiders from again attempting to effect a crossing in safety. At present surrounded by the fast growing city, and forming now one of Buffalo's Parks, is the American Fort Porter. This fort is one of the military posts of the United States, forming with Forts Niagara and Detroit, links in that chain of forts, which in the United States extends from Maine to Oregon. It is garrisoned by a detachment of United States infantry, whose services were of great value to the city in the great railroad riots of 1877. Three miles from Black Rock the most northerly suburb of Buffalo is the Island called Grand Island, containing about 80 square miles of land, and forming a Township in Erie County State of New York. Flowing due north through the middle of the Island, is a small creek, called Burnt Ship Creek, emptying itself into the Basin separating Buckhorn Island from Grand. In this Basin the French, in 1759, anchored two small vessels containing the reinforcements which had been sent from Venago to raise the siege of Fort Niagara, if possible, which at that time was beleagured by the British under Sir William Johnson. After landing the men on Isle la Marine, now called Navy Island, they burnt and sunk these ships. Until a few years ago the charred timbers of these vessels were distinctly visible, but now, owing to the gradual filling up of this basin, they have completely disappeared. Some years ago, while fishing in the clear water in company with some American friends, we noticed what we first thought was a sunken log; but American inquisitiveness when once aroused cannot be pacified, save by complete and satisfactory investigation. A grappling hook was obtained and a long rope. By continued exertion we dragged the object on shore, and it was certainly a curiosity. It was evidently a wheel which was used as part of a primitive machine for dragging these small vessels over the portages. The wheel was about 8 feet in diameter, and was, although composed of probably over a hundred distinct parts, made entirely of wood, there not being a particle of iron in its composition. The wood was oak, and although it had been under water for nearly 120 years, was not in the least affected by any kind of rot or decay. Being too cumbrous to transport, it was left on the shore of the Island, and

eventually the Philistine propensities of the agricultural natives destroyed this emblem of a departed age. I was fortunate enough the next year to be able to lay hold of some small pieces of the frame work, which I now have in my possession.

Going down the American channel past Tonawanda, with its miles of timber wharves, and directly east of Navy and Grand Islands, we come to Cayuga Island and creek, a mile from whose mouth is the village of La Salle. The name of René Cavelier dit La Salle occupies a place in early Canadian annals second only, if second, to that of Champlain himself. At the mouth of this creek, six miles above the falls, was built the first European craft that ever navigated the waters of the upper lakes, the ill-fated Griffin, whose fate must, like that of many a noble vessel in modern days, be a matter of conjecture, since, after carrying La Salle on his way to the Mississippi, it was never afterwards seen or heard of. The water of this creek, like that of all the streams flowing into the Niagara, is of a dark brown colour, in striking contrast with the clear blue of the river itself. Three miles below Cayuga Creek is Schlosser's Island and landing, pronounced by the degenerate inhabitant of the river Slusher's. Here was one end of the portage round the Falls of which the other end was nine miles below at Lewiston. Here the canoes of the Indian and voyageur once again entered the stream on their voyage from Fort Frontenac to the fur depots at Machilimackinac. The current is very mild along this shore of the river, and until the lower end of Grand Island is reached, when it becomes very rapid, the voyageurs could propel themselves as easily and rapidly as along a placid inland lake. In 1750 the French constructed a stockade and fort at this point which they appropriately called Fort La Portage. It was burnt in 1759 by Chabert Joncaire who was in command of it when the British commenced the glorious campaign against the French, which gave us the "brightest jewel in the British crown." A short time after this the fort was rebuilt by Captain Joseph Schlosser, a German, who had served in the British army throughout the campaign. A few inequalities in the surface of the ground now mark the site of the guardian of the Portage, but some twenty or thirty years ago the outlines and ditches were still quite distinct. A monument of antiquity still stands some yards below the remains of the Fort in the shape of a stone chimney, which was the centre point of the French barracks and storehouses previous to 1759. Several

houses have been at different times attached to it and have been burnt or destroyed, but still the chimney remains, solitary, moss-grown and grey, and will remain no doubt until the advancement of civilization and the necessities of commerce will cause its replacement by something more modern. It was at the wharf at Schlosser that the ill-fated steamer Caroline was fastened that night, in '37, when she was cut out by the loyalists from the Canadian shore. The Canadian militia, under Col. Allan McNab's command, at that time investing Navy Island, were in a complete state of ignorance concerning the river. The Falls were a source of great terror to the storming party, and a circuitous route was taken to reach Fort Schlosser that delayed them many hours. At present the hardy inhabitant of either shore safely crosses the river in a small boat or canoe within half a mile of the rapids, and adventurous youths land with impunity even on Goat Island, but in '37 the cutters out of the Caroline were esteemed greater heroes than even those who faced the bullets of the enemy; such is the power of nature compared with even the life-destroying gunpowder. The affair of the Caroline caused much international ill-feeling and was made the subject of much conjecturing and studying of international law. Evidently the same principles and arguments were quoted and cited, but by the opposite parties, when the Alabama claims came before the board of arbitrators at Geneva. Lying to the north-west of Grand Island, and west of Schlosser, is the small Island, formerly Isle la Marine, now Navy Island. The French, in 1759, built some small vessels on this Island, hence its name was literally translated when it came into possession of the English. Although hardly over three miles in circumference it was probably better known and more thought about, at one time of our national existence, than even Toronto itself. Here, in December, 1837, Wm. Lyon Mackenzie established his headquarters and issued his proclamations to the patriots, as the unfortunate rebels called themselves. In fact to this day, on the American side of the river, the trouble of '37 is referred to as the "patriot war." There was great uncertainty as to the number of the insurgents, who certainly had plenty of arms and ammunition. To this day may be seen in the upper rooms of the several farm houses on the Canadian shore the marks of the bullets, while every plowing turns up on Navy Island many a rusty cannon ball. There is still standing and

in good repair three miles from the Village of Chippawa, and directly opposite the head of Navy Island, the house in which Captain Usher was shot. Upon the door of this house is painted in white letters "No. 8, 20 men," evidently its billeting capacity. There are yet on the island two log huts or cottages which were occupied by Mr. and Mrs. Mackenzie. Although degraded to agricultural purposes they still seem destined to out-last several more modern structures built near them. There could not have been much peace of mind for any of the Reformers there; Sir Allan McNab, while not exposing his men to too much personal danger, continued to ply the rebels with shot and shell. While Mrs. Mackenzie was attending to some culinary operations one day a shell, plunging through the roof, fell into a barrel of beans which formed part of the stock of provisions, and burst, scattering a week's provender, but fortunately the inmates all escaped. For the greater security of his followers Mackenzie caused an open space to be cut out of the forest in the centre of the island. This is still known by the name of Mackenzie's Field, and is now used as a pasture for cattle. The proximity of the island to the United States, its great capabilities for defence and its commanding the entrance to the Welland River (which river is one of the entrances to the Welland Canal), combine in making it an outpost of great military value in time of war. On Navy Island may be seen many trees and flowers growing wild which cannot be found in any other place nearer than the Southern States; amongst others are the magnolia, sassafras, and several varieties of wild grapes. The apricot and nectarine are also grown and attain great perfection. A mile and a half from the head of Navy Island, on the Canadian side at the mouth of the Welland River, is the Village of Chippawa. It was at one time, before the building of the Welland Canal, a prosperous place. It was the head of navigation and a tramway ran from it to Queenston, the port at the other end of the Portage. But the canal and railway came and Chippawa suffered the common lot and decreased in trade and population in proportion as the larger towns grew. It is one of the oldest settled portions of Canada, John Cummings a U. E. Loyalist having settled there in 1782. It was the scene of several battles in the war of 1812 between the British and Americans. Several buildings are yet standing which were built previously to 1812, and in one of them may be seen a room at that time used as a prison; the rings and staples for securing the

prisoners are still there. At the mouth of the Welland River may be seen the outlines of a stockade and fort first constructed in 1812, and afterwards used in 1837. For the purposes of navigation and the security of the harbour, a canal about one hundred yards in length was cut from the southern shore of the Welland River through to the Niagara. The refuse earth was thrown to one side and has several times been mistaken for the ramparts of the old Fort. On making a personal investigation with several of the "oldest inhabitants" last year, we discovered distinct traces of the old Fort, only, however, a few yards from the mistaken ramparts. Chippawa, like Queenston, has fallen into decay, and has been completely outshadowed by the greater attractions at the Falls two miles away.

From Buffalo to the head of Navy Island the river is comparatively deep, averaging from twenty to thirty feet from shore to shore. Across the head of Navy Island the width is about two and a half miles. Opposite Chippewa it commences to narrow, and so on till the Falls are reached; the main, or "Canadian" current, as it is called, does not follow the middle of the river, but pursues a course of its own, running from the foot of Grand Island towards the American shore, past Schlosser's Island in a north-easterly direction, then, instead of following the straight course towards the head of Goat Island, it makes a sweep round the head of Grass Island towards the Canadian shore, almost due west, and skirting the banks just below Chippawa, flows precipitously over the Horse Shoe Fall. In the centre of the river, stretching from about half a mile above the rapids to within half a mile of Navy Island, there is a reef about two miles long and three-quarters of a mile broad. In no place on this reef is the water more than three feet deep, and at times during low water the heads of the larger stones peep above the surface. The water rushes over this reef at a great rate, and the bottom being composed entirely of rock, and the current not allowing any sediment to settle, the reef, on some windy days, to a stranger, looks very much like the commencement of the Rapids. On the American side of the river opposite to Chippawa a canal has been cut for water power; the opening of this canal forms a small harbour called Port Day. Several steam yachts are kept here, and as the channel does not extend along the American shore, these vessels have to strike across towards the Canadian shore before ascending the river. As this is only a few hundred yards above the rapids the sensations of nervous passengers

are not to be envied. The country back from the Canadian shore was formerly settled by U. E. Loyalists. At the present time, however, the farms are every day going into the hands of persons of German and American descent, the original settlers flocking to the cities. These new inhabitants of the river front have no sentimental regard for historical remains, and ruthlessly plow up and tear down anything that is not in strict conformity with agricultu al economy. In a very few years all that remains of Forts Erie, Schlosser and Porter will be swept away in "improvements." The relics of 1812 and 1837 will be sought for in vain by the archæologist, but the memory of the deeds that were done, and the devotion of the people who accomplished them, will live forever.

The following members took part in the discussion which followed:—The President, Mr. Murray, Prof. McMurrich, Mr. Livingstone and Dr. Workman.

TWENTY-FIRST ORDINARY MEETING.

The Twenty-first Ordinary Meeting of the Session 1883-84 was held on Saturday, April 5th, the Third Vice-President, Dr. George Kennedy, in the chair.

The minutes of last meeting were read and confirmed.

Mr. Chas. Levey, Mechanical Engineer, was elected a member of the Institute.

The following list of donations and exchanges received since last meeting was read:

1. Science, Vol. 3, No. 60, March 28, 1864.
2. Journal of the Franklin Institute for April, 1884.
3. Annual Report of Proceedings of the Belfast Naturalists' Field Club for 1882-83, Series 2, Vol. 2, Part 3.
4. Proceedings of the Academy of Natural Sciences of Philadelphia, Part 1, January to May, 1883, and Part 3, November and December, 1883.
5. Correspondenz-Blatt der Deutschen Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte, 15 Jahrgang, Nos. 2 und 3 Februar und März, 1884.
6. The Canadian Practitioner for April, 1884.
7. Le Courrier de Europe, Semaine Française, for 1884, presented by Mr. Geo. E. Shaw.

Dr. E. A. Meredith and Prof. Galbraith were appointed Auditors of the accounts of the Institute for the year ending March 31st, 1884.

Prof. McMurrich, presented by title, a paper "On the Myology of the Catfish."

Mr. T. McKenzie, B.A., then read an abstract of a paper by A. B. Macallum, M.A., on "The Alimentary System of the Catfish," after which Mr. McKenzie read a paper by himself, on the "Vascular System and Glands of the Catfish."

These papers will appear, together with others on the same general subject, in the concluding fasciculus of the present volume.

TWENTY-SECOND ORDINARY MEETING.

The Twenty-second Ordinary Meeting of the Session 1883-84 was held on Saturday, April 12th, the President in the chair.

The minutes of last meeting were read and confirmed.

The following list of donations and exchanges was read:

1. Transactions of the Manchester Geological Society, Vol. 17, part 14, Session 1883-84.
2. Science, Vol. 3, No. 61, for April 4, 1884.
3. (a) Records of the Geological Survey of India, Vol. 15, Part 4; Vol. 16, parts 1—3. Vol. 17, part 1.
   (b) Memoirs of the Geological Survey of India, Vol. 19, parts 2, 3 and 4.
   (c) " of Palaeontologia Indica, Series X., Vol. 2, part 4.
   " " " " X., " 2, " 6.
   " " " " XII., " 4, " 1.
   " " " " XIII., " 1, " 4, Fasciculi 1, 2.
   " " " " XIV., " 1, " 4.
4. Publications of the Oneida Historical Society at Utica, No. 5, January 13, 1880.
   (a) Second Annual Address before the Society, by William Tracy, of New York.
   (b) Historical Fallacies regarding Colonial New York.
5. Bulletin of the Philosophical Society of Washington, Vol. 6, 1884.
6. (a) Fifteenth Annual Report of the American Museum of Natural History (Central Park, New York), March, 1884.
   (b) Bulletin of the American Museum of Natural History (Central Park, N. Y.), Vol. 1, No. 5, February 13, 1884.

7. Appleton's Literary Bulletin, No. 4, April, 1884.
8. California State Mining Bureau: Third Annual Report of the State Mineralogist, for the year ending June 1st, 1883.
9. (*a*) Bulletin of the Essex Institute, Vol. 14, January to December, 1882, Nos. 1—12,
   (*b*) Pocket Guide to Salem, Mass., 1883.
   (*c*) Plummer Hall: Its Libraries, its Collections, its Historical Associations.
   (*d*) The North Shore, Massachusetts Bay, 6th Ed., 1883.
10. Anales del Museo Nacional de México, Tomo III., Entrega 5*a*.
11 (*a*) Proceedings of the Literary and Philosophical Society of Liverpool during the 59th Session, 1869-70, No. 24.
   (*b*) Proceedings of the same Society during the 62nd Session, 1872-73, No. 27.
12 (*a*) Transactions of the Cambridge Philosophical Society, Vol. 11, parts 1 and 2; Vol. 13, part 3.
   (*b*) Proceedings of the Cambridge Philosophical Society, Vol. 1, 1843-1865, 16 Nos. complete; Vol. 2, 1866 to 1876, parts 1—17, complete; Vol. 4, part 6, for 1883.
13. Sitzungsberichte und Abhandlungen der Naturwissenschaftlichen Gesellschaft, "Isis," in Dresden, 1883, Juli bis December.
14. L'Académie Royale de Copenhague, Bulletin pour 1883, No. 2, (Mars-Mai.)
15. (*a*) Annuaire de L'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique, for 1881, 1882 and 1883; 47th to 49th year, Bruxelles, (3 Vols.)
   (*b*) Bulletin de L'Académie Royale de Belgique, 49*me* Année, 2*me* Série 1880, Tome 1; 50*me* Année, 3*me* Série, 1881, Tome 1, 2; 51*me* Année, 3*me* Série, 1882, Tome 3*me*, et 4*me*; 52*me* Année, 3*me* Série, 1883, Tome 5*me*, (6 Vols.)

Dr. E. A. Meredith then read a paper entitled:—

"COMPULSORY EDUCATION IN CRIME."

The reader of the paper contended that so far as regards the suppression of vice and crime, our Common or County jails were little better than the abominable dens which Howard visited and denounced more than a century ago. Philanthropists, social reformers and Prison Congresses had worked earnestly during the last thirty or forty years, and their labours had in other departments produced good results. In institutions for saving children, such as Homes, Refuges and Industrial Schools, extraordinary progress had been made and in convict prisons for adults an extraordinary revolution had been carried out with equal success, especially in those conducted under the so-called "Crofter" or "Irish" system. The Common Jails alone lagged behind the age, and the reason probably is that they were the only institutions managed by *municipal bodies*, the others

being either under the control of the State or of private individuals or societies. The jails have been improved materially, but not morally. The giant evil of Howard's time, the indiscriminate association of the prisoners is still permitted in the great majority of jails on the continent, whether in the United States or Canada. The jails had ceased to be in any sense either *deterrent* or *reformatory;* they are, on the contrary, *attractive* to criminals and to the last degree demoralizing to the inmates. They are nurseries of crime, hotbeds of vice, where criminals are manufactured at the cost of the country. The only remedy for this disgraceful state of things is the introduction of the " Separate System," a system which had been approved by all authorities on the subject, and carried out with marvellous success in many jails in England and on the continent of Europe, and in some few in the United States. The great merit of the separate system is that it stops the corruption and contamination which indiscriminate association of prisoners necessarily produces. In other words it puts an end to the " Compulsory Education in Crime " now going on in all our jails; and more than this, it represses crime, both by its deterrent and reforming influences. Dr. Meredith recommended that the separate system be made obligatory in all jails so soon as these are fitted for it.

In answer to a question by the President, Dr. Meredith explained that " Solitary Confinement " was stricter than " Separate Confinement," which latter meant merely separation from injurious influences, and not from visits of those who may benefit the prisoners. These would be brought together only under supervision.

Mr. B. B. Hughes spoke in high terms of the manner in which the Reformatory at Penetanguishene was conducted.

Mr. Douglas hoped that the Legislature would do something to remedy the evils mentioned in Dr. Meredith's paper.

Mr. Geo. Murray thought that young children should not be sent to the same prison as adults. He would endeavour to sift out the worse juvenile criminals, and he believed a large majority would remain with which we could deal in the way of reformation.

TWENTY-THIRD ORDINARY MEETING.

The Twenty-third Ordinary Meeting of the Session 1883-84 was held on Saturday, April 19th, the President in the chair.

The minutes of last meeting were read and confirmed.

The Rev. Hugh Johnston, M. A., B. D., was elected a member of the Institute.

The following list of donations and exchanges received since last meeting was read :

1. Memoirs of the Boston Society of Natural History, Vol. 3, No. 9, March, 1884.
2. Science, Vol. 3, No. 62, for April 11th, 1884.
3. The Manitoba Gazette, March 31st, and April 5th.
4. Journal of the Asiatic Society of Bengal, Vol. 52, Part 2, Nos. 2, 3, 4, 1883. Proceedings of the Asiatic Society of Bengal, No. 9, November, 1883.
5. The Canadian Entomologist, Vol. 16, No. 2, February, 1884.
6. Proceedings of the Royal Geographical Society, N. S., Vol. 6, No. 4, April, 1884.
7. Atti della Società Toscana di Scienze Naturali, Processi Verbali, Vol. 4, pp. 29-52. Processi Verbali, Indice del, Vol. 1, pp. 133 to 138.
8. Meteorological Service, Dominion of Canada, Monthly Weather Review, March, 1884.
9. Oneida Historical Society, 1879, Men of Early Rome, by D. E. Wager.

Capt. Gamble Geddes, A. D. C., then read a paper entitled,

AN ENTOMOLOGICAL TRIP IN THE ROCKIES.

MR. PRESIDENT AND GENTLEMEN,

It is with great pleasure that I take advantage of your kind invitation to read a brief paper upon a trip made by me to the Rocky Mountains last summer. As my object in undertaking this long journey was purely "Entomological," I had intended to prepare and read to you a paper upon the genera "Coliadæ" and "Argynnidæ," of our Diurnal Lepidoptera, (two of my favourite families,) but at the request of some of my friends, I am going to give you a rough outline of the entire trip, trusting that I may be enabled to make it of more interest to you, by exhibiting a few of the specimens and relics picked up by the way.

With this short preface and with your kind indulgence, I will begin:

The different points of interest between here and Winnipeg have been so thoroughly discussed by tourists of late years that it is needless for me to refer to my trip until a start is made from Winnipeg on June 9th, 1883.

The main object of this journey, was to make a collection of insects and especially of Rhopaloceres or the day butterflies, the first of the two great divisions into which the Lepidoptera have been divided. The different species of this division all fly by day: they have the antennæ terminated by a knob or club and comprise the Papilionidæ, Pieridœ, Lycœnidæ, Erycinidæ, Litytheadæ, Satyridæ, Hesperidæ, and so on.

The Heteroæres, the greater portion of which fly by night, embrace the Sphingidæ, Bombycidæ, Noctuæ, Geometridæ, &c., &c. In this division the most noticeable feature of distinction is the antennæ, which are of a feather-like appearance and taper to a point at the ends instead of the knob or club that the majority of the diurnals have.

I do not intend to enter into detail with regard to the species which I captured *en route*, but more to give a brief sketch of the trip and the beauty of the country through which I passed, as well as the barren parts.

After leaving Brandon on the 11th June, the next point of interest was Moosomin where we lay over a day, to visit Fort Ellis and Binscarth. The former is an old fort under the charge of Mr. W. J. McLean, a faithful officer of the H. B. C. The party with whom I was travelling were going on to Binscarth, the "stock farm," and property of the Scottish Ontario Co.

As Mr. McLean offered me the hospitality of the Fort, I decided to remain over and make such additions to my collections, as were to be taken in the neighbourhood of Fort Ellis.

I was well rewarded for my pains, as I succeeded in making some rare captures. Fort Ellis is situated 30 miles from the C. P. R. track and about 20 miles from Binscarth.

Here the Blackfeet and the Sioux Indians, (principally the former) were congregated in large numbers around the Fort. Their "tepees" or lodges were thick in every direction, and I had the opportunity of seeing how the Government agents distributed the pork, flour and blankets to those Indians who deserve them.

I was advised to go out with some of the squaws of the Blackfeet tribe, and get some wild turnips, though *why* they are so called, I never could and never will imagine. The root of the plant resembles the bulb of a small tulip, and when the outer skin is removed, the heart of the bulb tastes something like the kernel of an almond and quite as dry. The leaf of the plant reminded me of the lupin (perenniel), but it was too early in the season to take the flower, as a specimen.

The women of the Blackfeet and Sioux seem particularly partial to these roots. Armed with genuine "crow-bars" of *iron*, about four feet in length and from one and a-half inches to 2 inches in diameter, we sallied forth. It was a matter of amazement to me, to see the manner in which the squaws handled these iron bars. On the side of a steep hill they would let themselves down and holding on to a shrub, or the end of a rock with one hand they would with the other hand wield the bar (always pointed at the end) and soon the roots, which were generally about four inches to six inches down in the soil, would be dislodged. I tried to handle one of these bars myself and as I had to use two hands and the combined strength of my two arms to boot, I appeared to cause much merriment to my redskin friends, who looked upon me as a very poor specimen of the human race. I had a chance of purchasing a few samples of the bead-work of the Sioux women, a few articles of which I have brought with me, also one or two of their favourite pipes.

On the 15th June we reached Medicine Hat and the end of the track of the C. P. R., which had just then crossed the Saskatchewan River on a temporary trellis-work bridge. Here we had an opportunity of witnessing the wonderful rapidity with which this road was constructed; the contractors at that time were building from three to five miles a day.

On June 25th we started for Calgarry. On the 27th we reached the Bow River. The mosquitos were terrific. During the night our camp was set on fire by Indians, who hoped to make a stampede with our horses. Luckily, we discovered the grass on fire in two places, in time to put it out with wet blankets, and so saved our property.

The flora between Calgarry and Edmonton (my next halting-place) was simply lovely. The orange and cardinal lilies, or, as the Cree Indians call them, "Wappiconnaisa," the yellow ladies' slippers,

anemones, wild rhubarb blossom, 4 feet high, and the plumed head of that lovely flower. Geum Triflorum, made a charming contrast to the innumerable shades of green of the foliage. As one looked into the different "coolies" and "hollows" in the prairie in passing, it appeared to be like a rich carpet of most exquisite workmanship and colouring, but far, far more beautiful.

Upon the 7th July we reached Edmonton, and it became apparent that we were getting much farther to the north, as the days were so long and the nights so very short. I was surprised to hear from the proprietor of the hotel at Edmonton that upon the Sunday previous to our arrival he had put green peas from his own garden upon the table for his guests at dinner. I was not so much surprised however to see what he showed me the same evening we arrived, and that was half a field of beautiful potatoes cut off by the summer frosts and looking as black as ink alongside the other half, which had escaped. It was just as if some one had taken a ruler and drawn a line from one corner of the field to the other, and then painted one half black and the other green. I was very much disgusted with the cold and windy weather that we had at this point. It was impossible to collect butterflies and moths, and I was not at all sorry to start off again for the south.

On July 16th we reached Calgarry on the return trip. Here I met some old friends, and on the 19th July started off for Fort Macleod. This was a very interesting part of the trip, as we stopped at several ranches, amongst them "Oxley Ranche," the property of Mr. Staveley Hill and other English gentlemen, and the ranche of Mr. Stinson at High River. I must not forget to mention that at all the ranches I stopped at on my long journey and at all the posts of the Hudson Bay Co., I received the greatest hospitality, likewise from the N. W. Mounted Police. Whilst amongst the ranches I learned that the cow-boy's whip was called a "Quoit;" the rope for catching horses in "corral" is called a "Mecarte," a "Lariet" being a grass rope for the same purpose. "Chaps" or "chaparellos," are the leather breeches or leggings used for riding, and so on.

On July 24th I spent a rare day of collecting at Pincher Creek, being then the guest of Lieut.-Col. Macleod; also three or four days following I did good work, taking Argynnis Clio, Argynnis Artonis, as well as many rare Coliadæ.

Aug. 1—At the Garnett Ranche, a lovely Ranche in the foot-hills of the Rockies, where the peaks of the mountains tower above one over three sides of the ranche. Here I took many rare insects.

I met Dr. George Dawson, of the Geological Survey of Canada, and his party, at the Garnett Ranche. He had just returned from the Crow's Nest Pass, with specimens of natural history *generally*, but with notes upon the geological formations of the country *in particular*. I took here a new Polyomatus or Chrysophanus called Florus by Mr. W. H. Edwards, of Coalburgh, West Virginia).

Whilst a guest at the Garnett Ranche, I went out with one of the proprietors to get some trout. When I was catching butterflies, he was catching trout, averaging about 1½ lbs. each. He took 17 fine fish in a very short time. Upon the 4th August we reached our camping ground at the Crow's Nest Pass, and a lovely spot it was. Through the kindness of Col. Macleod, I was enabled to take along with me a folding boat made of canvas, with which we explored the lakes near the summit of the mountains known as the "Big Fish Lakes," and judging from the size of the fish taken, the name was very appropriate. I did some rare collecting through this new country, taking the ♀ Hermodur, a species described by Mr. Henry Edwards as a var. of Parnassius Smintheus, also Arg. Chariclea and Arg. Boisduvallii, Chrysophanus Mariposa and Thecla Edwardsii, one solitary specimen. We met large bands of the Stoncy Indians throughout this Pass, who were trapping, shooting, and fishing. The Indians supplied us with meat from the mountain sheep or big horn (Ovis Montana), which made a delicious steak when broiled, reminding one both of mutton and venison. The band of Indians who were camping close to us were trapping beaver, and hunting bear and sheep, principally.

Whilst at Big Fish Lake, I saw three fine trout caught (more than once) at one cast, by Mr. Arthur Garnett, one of the most experienced fishermen I have ever met. I may say that our living here was really luxurious, after feeding on fat pork and porridge for a long time, the variety in our fare was most welcome, I can assure you. Let me advise any of you, gentlemen, who ever go for a trip to the Mountains to be well provided with fishing tackle, and lots of it, besides a good rifle, and shot gun as well. These articles are infinitesimally small in comparison with the "prog" you would have to pack your horses with, and with a bag of flour and some bacon

you can live well. It is not absolutely necessary to take canned meat and vegetables along with you, as many explorers do, for in this lovely country you are independent, so to speak, with the quantity of fish and game that is always on hand in the neighbourhood.

After reaching the summit of the Mountains here, and returning to my headquarters in camp, we started back to the District of Old Man's River. Upon August 15th, I found myself at the Belly River District, from which place I started for the Koutanai Lakes. All through this beautiful grazing country, I was perfectly delighted with everything I saw.

The ranchers were all busy taking in hay for winter emergencies, although it is seldom required, for the snow is seldom too deep for the cattle to scratch it up to feed on the long grass underneath. The Chenook wind which blows through the mountains from the Pacific Ocean, melts the snow nearly as soon as it makes its appearance, and wheeled vehicles, principally heavy carts and buck boards supply the place of sleighs. From the Muirhead Ranche, I started out for the so-called Koutanai Lakes, where I was successful in capturing many fine butterflies, amongst them *Argynnis Leto*, ♂ and ♀.

The guide who took me up to the Lakes killed two grisly bears whilst I was in this part of the mountains, and I brought the skins back with me as a memento of the trip.

The name of the hills that one meets with on the prairie is "bute" and "cooley" or "lie" is applied to all hollow spots or valleys.

I must warn all who may be disposed to make a summer excursion through the mountains to the British Columbia side, to be well provided with a musquito-net; I mean by this not only the small nets to wear over one's head and neck whilst riding or driving, but a strong net, capable of being fastened to the tent inside, and covering one's entire body at night time.

It may not be out of place here to relate one or two anecdotes about the extraordinary numbers of musquitos that infest the entire district through which I passed—not forgetting to mention the black-flies, sand-flies, horse-flies or "bull-dogs" as the old settlers call them, and the greatest *torment* of all the flying ants.

I remember one evening after we had pitched our tent for the night, and just about dusk, I set off with one of my fellow-travellers to inspect a curious rock, which was standing upright in the midst of

a vast plain, with no other sign of stones or gravel of any kind anywhere near it. Our fire in the camp had driven the musquitos away from the immediate neighbourhood, and for the time I quite forgot the existence of these pests. My friend was wearing a dark blue pea-jacket and walked before me. Fortunately he was provided with a net to cover his face, but I had foolishly left mine behind. As soon as we stirred up the long grass with our feet, the musquitos arose in myriads, and after fighting them off for a short time, I looked ahead at my companion, and I declare I could not tell what colour his coat was, so thickly was his back covered with the insects, I confess that this was too much for me, and I turned and fled to the camp as fast as my legs would carry me in a most ignominious fashion.

In case you have not seen a "smudge" or read of one, I will describe it. A "smudge" is a refuge for horses and cattle that are attacked by flies and mosquitos. A "square" of logs dove-tailed at the four corners, is constructed just high enough to allow a horse standing up to put his head over the topmost log. Inside this square and on the ground you set fire to leaves and grass, and pile on to this wet foliage of plants, and make a heavy suffocating smoke. The horses will run madly towards this smoke from wherever they may be and hold their heads where the smoke is thickest. It is absolutely necessary to build a barricade of logs round these fires, as the horses will burn themselves in the fire often rather than suffer the torment of the flies.

Whilst driving one day to the Koutanai Lakes we had to pass through a cloud of black flying ants. My guide and I were both well covered up, but he had on a light-coloured felt hat which seemed to have some peculiar attraction, for they attacked him vigorously; there was a small opening at the back of his neck between his hat and the top of his coat-collar, and the ants fairly gnawed away that portion of his neck which was exposed. We came across a very intelligent man who acts as guide to exploring parties in the Koutanai District. He lives in a most lonely situation, quite near the mouth of the Koutanai Pass. He is familiarly known as Koutanai Brown, and I would recommend any one going to that solitary neighborhood to patronize this guide. He is a dead shot with a rifle and an excellent fisherman. He makes his living by trading to some extent with the Indians and shooting sheep and bears, himself. We had plenty of bear's meat while with Koutanai Brown. But as it had been

dried in the sun, (and not smoked) it was decidedly "odoriferous," and I preferred watching the others enjoy it and partaking of salt pork instead.

I would like to call your attention on the map for a moment to the stretch of country lying between the Red Deer River and Fort Edmonton. Here the shrubs begin to appear as trees, and the trees increase in size as one proceeds north. Very fine timber is to be had in and around Edmonton and all along the banks of the Saskatchewan. Amongst all the farmers we met between Calgarry and Edmonton (with one exception), the opinion expressed as to the quality of the land and the nature of the climate, was unanimous. All agreed in saying that although the winters were severe, yet they could grow such fine crops and so rapidly, that the brief summer was amply long to mature the grain and get it harvested.

In conclusion, I have with me a list of the diurnals taken by me during this tour, and for the benefit of those entomologists who are present, I have looked it over and will call their attention to several of the species which are rare and which I will be glad to point out to them in my cases. I regret that I could not bring my cabinets down here to show my collection to the members of the Institute, but I will only say to those who are interested in this fascinating study, that it will afford me the greatest possible pleasure to look over my cabinets at Government House with them at any time that I may be honoured by a visit.

Thanking you gentlemen, for your kind attention, and trusting that I have not been encroaching too much upon your time, I beg to conclude.

LIST OF DIURNAL LEPIDOPTERA COLLECTED IN THE NORTH-WEST TERRITORY AND THE ROCKY MOUNTAINS.

1. Papilio Asterias, F. Edmonton.
2. " Troilus, L. Fort Macleod.
3. " Turnus, L. "
4. " Glaucus, L. "
5. " Eurymedon, Bd. Seen but not taken.
6. Parnassius Smintheus, Doubd. Crow's Nest Pass.
7. Dark var. Hermodur, H. Edw. Summit Pass.
8. Pieris Oleracea, Boisd. Koutanai.
9. " Occidentalis, Reak. Pincher Creek.
10. " Protodice, Boisd. Belly River.
11. " Rapæ, L. N. W. T.

12. Anthocaris Olympia, Edw. (v. rare). Summit.
13. " Ausonides, Boisd. Calgarry.
14. Colias Christina, Edw. Red Deer River.
15. " Occidentalis, Scud. (rare). Edmonton.
16. " Edwardsii, Behr. (rare). Edmonton.
17. " Astrea, Edw. (♀ new). Red Deer River.
18. " Alexandra, Edw. (rare) 5,000 ft. elevation Rocky Mountains.
19. " Eurytheme, Boisd. (rare). None taken W. of Moose Jaw.
20. " Hagenii, Edw. Fort Macleod.
21. " " " (diminutive form). Fort Macleod.
22. " Scudderii, Reak. Koutanai.
23. Argynnis Lais, N. S., Edw. Fort Edmonton.
24. " Cybele, F. " "
25. " Baucis, Edw. (not proved new yet). Fort Edmonton.
26. " Coronis, Behr. Belly River.
27. " " (dark varieties). Crow's Nest.
28. " Chariclea, Schneid. Crow's Nest.
29. " Boisduvalii, "
30. " Atlantis, Edw. "
31. " Eurynome, Edw. Belly River.
32. " V. Erinna. Red Deer River.
33. " V. Arge (?), Streck, Calgarry.
34. " Clio, Edw. (v. rare). Crow's Nest.
35. " Monticola, Behr. (v. rare). Summit.
36. " Edwardsii, Reak. (v. rare). Blackfoot Reserve.
37. " Artonis, Edw. (v. rare). Koutanai.
38. " Myrina, Cram. Edmonton.
39. " Aphrodite, F. "
40. Melitæa Nubigena, Behr. Crow's Nest.
41. " Palla (?), Boisd. "
42. " Chalcedon (?), Boisd. Garnett Ranche.
43. " Leanira. " "
44. Limenitis Disippus, Godt. Crow's Nest.
45. " Lorquini, Boisd. "
46. " Arthemis, Drury. N. W. T.
47. Vanessa Milberti, Godt, N. W. T.
48. " Antiopa, L. N. W. T.
49. Pyrameis Atalánta, L. N. W. T.
50. Grapta Satyrus, Edw. Crow's Nest.
51. " Progne, Cram. Fort Macleod.
52. Danais Archippus, F. Common.
53. Chionobas Chryxus, West (v. rare). Summit.
54. " Varuna, Edw. Calgarry.
55. " Uhleri (?), Reak. "
56. Erebia Epipsodea, Butl. Fort Ellis.

57. Satyrus Charon, Edw. Garnett Ranche.
58. " Silvestris, Edw. "
59. " Nephele, Kirby. Rocky Mountains.
60. " V. Boopis, Behr. "
61. " V. Ariana, Boisd. "
62. " V. Olympus, Edw. "
63. Cœnonympha Inornata, Edw. Calgarry and Edmonton.
64. " Ochracea, Edw. " "
65. Phyciodes Carlota, Reak. Brandon.
66. " Tharos, Drury. Edmonton.
67–68. Several varieties from North of Edmonton. Not determined.
69. Thecla Titus, F. Old Man's River.
70. " Edwardsii, Saund. (rare). Summit.
71. Chrysophanus Mariposa, Reak. (v. rare). Summit.
72. " Florus, Edw., Nov. Spec. (v. rare). Garnett's Ranche.
73. " Helloides, Boisd. Oxley Ranche.
74. " Americana, D'Urban. "
75. " Sirius, Edw. (v. rare). Fort Macleod.
76. Pyrgus Tessellata, Scud. Medicine Hat.
77. Amblyscirtes Vialis, Edw. (v. rare). Fort Ellis.
78. Thymelicus Garita, Reak. Fort Ellis.
79. Thanaos Brizo, Boisd. Fort Ellis.
80. Eudamus Pylades, Scud. "
81. Lycæna Anna, Edw. Belly River.
82. " Amyntula, Boisd. Calgarry.
83. " Sæpiolus, Boisd. Crow's Nest.
84. " Rustica. Fort Qu'Appelle.
85. " Pembina, Edw. Crow's Nest.
86. " Afra, Edw. Nov. Spec. Saskatchewan.
87. " Unknown Spec. sent for identification. Garnett Ranche.
88. Pamphila Zabulon, Bd. Lec. Calgarry.
89. " Manataaqua, Scud. (v. rare). Fort Macleod.
90. " Manitoba. Belly River.
91. " Uncas, Edw. "
92. " Cernes, Bd. Lec. Crow's Nest.
93. Argynnis Leto ♀, Behr. Fort Macleod.
94. " Bellona F. Fort Ellis.
95. Lycæna Fulla, Ew.
96. " Melissa Edw. Oxley Ranche.
97. " Neglecta, Edw. Fort Ellis.
98. " Lygdamas, Doubld. Fort Ellis.
99. " Icaroides, Bd. Red Deer River.
100. Pamphila Nevada, Edw. (?) Fort Macleod.
101. " Colorado, Scud. Medicine Hat.
102. " Idaho, Edw. Moose Jaw.

103. Pyciodes Camillus, Edw. Edmonton.
104. " Marcia, Edw. Edmonton.
105. " Nycteis, Doubld. Edmonton.
106. Argynnis Nevadennis, Edw. Calgarry.

The President, Dr. Bryce, Mr. Chas. Levey and Mr. B. B. Hughes took part in the discussion which followed.

TWENTY-FOURTH ORDINARY MEETING.

The Twenty-fourth Ordinary Meeting of the Session 1883-84 was held on Saturday, April 26th, 1884, the President in the chair.

The minutes of last meeting were read and confirmed.

The nomination of Office-bearers and Members of Council was made.

A communication was read from Mr. W. Thompson, President elect of Section A of the British Association for the Advancement of Science, giving notice of special discussions in the Section of Mathematical and Physical Science.

The following list of donations and exchanges was read :

1. Journal of the Transactions of the Victoria Institute, Vol. 17, No. 68.
2. List of Members, Council, &c., of the Royal Society of Edinburgh, November, 1883.
3. Science, Vol. 3, No. 63, April 18, 1884.
4. Ninth Annual Report of the Ontario Agricultural College and Experimental Farm for 1883.
5. Report of the Entomological Society of Ontario for 1883.
6. Science Record, Vol. 2, No. 6, April 15, 1884.
7. Report of Speeches at the Annual Dinner of the Institution of Civil Engineers, March 26, 1884.

Mr. Henry S. Howland, jun., then read a paper entitled,

"THE ART OF ETCHING."

Mr. Howland opened his subject with the following words:

"Very often we, who are engaged in mercantile life, seem to lose sight of the great value of having some interests, some tastes and some pursuits independent of, and in many ways directly opposite in their influence, to our regular business—something to engage our leisure moments, to keep us from becoming too much absorbed in the

mere material and hardening act of money-getting, and at the same time by directing our thoughts into a different course, to be a wholesome recreation to our minds and a means of ennobling our hearts.

"Our long and wearisome days of business are usually spent in work without much change, our whole attention directed to practical things the poetical instincts of our natures receiving no culture, and so lacking development, unless quickened into life and activity by some powerful influence. * * *

"Now, while not at all asserting that we should not give to our business the care and attention which it may need, for indeed to make a true success of it, it must be uppermost in our thoughts, but just because of that very thing, because man, by the very constitution of his nature, needs variety and change, or he will develop into a mere machine, or, perchance, his health may fail, he must become interested in something else. And while giving to science and philosophy the tribute of respect and admiration which is their due, I insist that poetry, that painting, that architecture, that music, the fine arts in fact, will appeal to something in man's nature, which science, philosophy, the professions, or branches of mercantile industry, cannot reach. There is a part of man's nature which responds to beauty as to an electric thrill."

Mr. Howland then gave a brief history of the "Art of Etching" as first practiced by Dürer about 1518, with its bright and its dark days, to its decline and comparative obscurity at the commencement of the present century, with its revival about 1860, and gradual growth in popularity to the present day.

The practical part was then carefully described, Mr. Howland illustrating the processes and modes of treatment, with plates and implements used. "Etching really means drawing upon a plate, generally of copper, which has previously been coated with a varnish-like substance called *ground*, with a point which removes the varnish wherever it touches, and then subjecting these exposed parts to the biting of an acid, so as to leave actual hollows in the metal."

Mr. Howland mentioned the names of Haden, Hamerton, Palmer, Whistler, Chattock, Law, Lelanne, Méryon, Jacquemart as being the leading etchers in Europe.

In America Stephen Parish, of Philadelphia, probably stands the highest, and we owe a great deal to such men as Henry Farrer, Thomas Moran, J. T. Bentley, F. S. Church, R. S. Gifford, Wm.

Sartain, J. C. Nicoll, Jas. D. Smillie, K. Van Elten, Walter Shirlaw, J. F. Sabin, F. Dielman, J. F. Cole, E. H. Miller, P. Moran, M. N. Moran, Samuel Coleman, for the work they have given us.

Mr. Howland expressed himself especially indebted to Mr. Stephen Parish, who was very generous in lending him a plate on which he had etched a picture called "An Old Acadian Inn-yard." Mr. R. J. Kimball, of New York, was very kind in sending a plate by Mr. Henry Farrer, President of the "New York Etching Club."

Mr. J. F. Bentley, a Canadian, now living in New York, kindly sent a large artist's proof of his picture called the "South Porch of St. Ouen."

Thanks are due to Mr. Jardine, Secretary of the "Ontario Society of Artists," for his kindness in lending a large collection of etchings. Not only did he volunteer the pictures, but he spent the greater part of an afternoon in hanging them.

Mr. Howland ended his paper with a short description of the beauties of etching, illustrated by a large number of etchings from the time of the invention of the art to the present day, and hoped that, the appreciation and support of this attractive art would go on increasing.

"When the artist by his skill awakens in those who view his pictures feelings or emotions similar to the promptings he had in the conception of his work, he is much nearer true art than when, by careful and minute detail, he gives the conscious feeling of reality. Hence in this particular, etching really seems well adapted for expressing the highest art. Something is given to awaken thought, rather than a passing pleasure only."

After the reading of the paper, the members present were invited to inspect the etchings which Mr. Howland had collected to illustrate his subject.

THIRTY-FIFTH ANNUAL MEETING.

The Thirty-fifth Annual Meeting was held on Saturday, May 3rd, the Second Vice-President, Mr. George Murray, in the chair.

The Minutes of last Annual Meeting were read and confirmed.

The following list of donations and exchanges received during the preceding week was read:

1. Science, Vol. 3, No. 64, April 25, 1884.
2. Verhandlungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte, Sitzung vom 20 Jan., 10 Feb., 17 Feb., 17 März, 21 April, 19 Mai, 16 Juni, 21 Juli, 20 October, Nov. 17 and 24, Dec. 15, 1883. 12 Numbers.
3. Report of the Canadian Observations of the Transit of Venus, 6 December, 1882.
4. (1) Bulletin of the Natural History Society of New Brunswick, No. 3, 1884.
   (2) Annual Report of New Brunswick Natural History Society. Memorial Sketch of Prof. Ch. Fred. Hartt, by George U. Hay.
5. Bulletin of the Museum of Comparative Zoölogy at Harvard College, Cambridge.
   Vol. 1, Complete.
   " 2, Nos. 2-5.
   " 3, " 3, 6-16.
   " 5, " 1, 7-12, 14-16.
   " 6, complete.
   " 7, Nos. 2-10.
6. Journal of the Franklin Institute for May, 1884.
7. Journal of the Microscopical Society for April, 1884.
8. The Canadian Practitioner for May, 1884.
9. Proceedings of the Worcester Society of Antiquity for 1883, No. 20.

The following gentlemen were elected Honorary Members of the Canadian Institute:

Daniel Wilson, LL.D., Rev. John McCaul, D.D., Prof. Balfour Stewart, (Owen College, Manchester,) and the Abbé Provencher, Cap Rouge, Quebec.

The Hon. Secretary read the Annual Report of the Council as follows:

ANNUAL REPORT, SESSION 1883-84.

The Council of the Canadian Institute have the honour to lay before the members their Thirty-fifth Annual Report.

The attendance at the weekly meetings has been satisfactory, and a large number of papers have been read. These will compare favorably in average merit with those of any preceding Session. In addition to the regular work of the Institute, a course of three popular public lectures on sanitary subjects

was arranged for and delivered in the Library under the joint auspices of the Institute and the Provincial Board of Health. The lecturers were Dr. Oldright, Dr. Cassidy and Dr. Bryce.

The number of members has increased from 225 to 236, and a larger number than heretofore have made use of the reading-room and library. As will be seen by reference to one of the appendices to this report, the number of books and periodicals taken out by members has nearly doubled. The number of Societies with which we exchange publications is now 140. The number of donations and exchanges received has been 800, as against 280 during the preceding year. One hundred and twenty volumes have been bound, and eighty volumes and numbers purchased to complete sets. It is much to be desired that funds should be forthcoming to bind the whole of the 700 volumes that are now awaiting the binder.

A change has been made in the method of publishing the Proceedings, which, it is believed, will have the effect of rendering our transactions more acceptable to our members without rendering them less valuable to other Societies.

The Council having devoted so much attention to the Library, Reading-room, Journal and Exchanges, has not been able to put the collections in the museum in order or increase them. This department, however, has not been altogether neglected. A few valuable skins have been stuffed, and the very handsome offer made by Mr. Brodie to furnish a collection of insects, provided the Institute supplied cases, has been accepted, and a number of cases have been placed at his disposal.

Herewith are submitted appendices, showing (1) the membership, (2) the financial condition of the Institute, which will be found very satisfactory, (3) the number and sources of the donations and exchanges, (4) the number of books and periodicals issued to members, (5) the list of periodicals subscribed for, and (6) the list of periodicals presented to the Institute, with the names of the donors.

All of which is respectfully submitted.

J. M. BUCHAN,
PRESIDENT.

APPENDIX I.

MEMBERSHIP.

Number of Members, March 31st, 1883	225
Withdrawals and Deaths during the past year	25
	200
Elected during the Session 1883-84	36
Total number of Members, April 1st, 1884	236

Composed of:

Corresponding Member	1
Honorary Member	1
Life Members	17
Ordinary Members	217
Total	236

APPENDIX II.

TREASURER IN ACCOUNT WITH THE CANADIAN INSTITUTE, SESSION OF 1883-4.

To Summary	$ cts.
" Balance on hand	689 04
" Annual Subscriptions	588 00
" Rents	179 50
" Journals Sold	17 25
" Interest on Deposits	17 10
" Freight	1 20
	$1,492 09

By Summary	$ cts.
" Salaries	286 47
" Periodicals	244 34
" Interest on Mortgage	238 78
" Printing	222 79
" Fuel	142 23
" Postage	78 07
" Express	34 82
" Gas	42 19
" Furniture	32 80
" Stationery	25 92
" Repairs	24 39
" Water	24 00
" Contingencies	14 30
" Taxes	9 49
" Cash in Bank	71 50
	$1,492 09

Assets.

Building	$11,000 00
Warehouse	720 00
Ground	2,500 00
Library	5,500 00
Specimens	1,200 00
Personal Property	400 00
	$21,320 00

Liabilities.[1]

Mortgage	$3,411 00
Balance in favour of Institute	17,909 00
	$21,320 00

Examined, compared with vouchers and found correct.

E. A. MEREDITH, } *Auditors.*
J. GALBRAITH, }

14th April, 1884.

APPENDIX III.

DONATIONS AND EXCHANGES.

Books and Pamphlets received from—

April 1, 1882, to April 1, 1883.		April 1, 1883, to April 1, 1884.	
Canadian	30	Canadian	90
United States	60	United States	300
Great Britain and Ireland	100	Great Britain and Ireland	200
India, and other British Colonies, exclusive of Canada	20	India, and other British Colonies, exclusive of Canada	40
Foreign	70	Foreign	170
Total	280	Total	800

The number of Societies with which the Institute exchanges is.. 140

The following are the principal Institutions that have supplied back numbers of their publications to completed sets.

Smithsonian Institution.
Essex Institute.
New York Academy of Sciences.
Academy of Natural Sciences, Philadelphia.
Worcester Society of Antiquity.
Harvard University Library.
Museum of Comparative Zoölogy at Harvard College.
Connecticut Academy of Arts and Sciences.
Historical Society of Pennsylvania.
Peabody Institute, Baltimore.
Entomological Society of Ontario.
Royal Scottish Society of Arts.
Anthropological Institute of Great Britain and Ireland.
Cambridge Philosophical Society.
Leeds Philosophical Society.
Royal Geological Society of Ireland.
Royal Dublin Society.
Royal Colonial Institute.
Royal Geographical Society.
Institution of Civil Engineers, G. B.
The Victoria Institute.
The Linnean Society.
New Zealand Institute.
Naturwissenschaftliche Gesellschaft "Isis," Dresden.
The Literary and Philosophical Society, of Liverpool.

NOTE.—The donations presented by the above, and some others have already been given in detail.

APPENDIX IV.

The number of books and periodicals issued to members :—

(1)	From April 1, 1882, to April 1, 1883	450
(2)	" " 1, 1883, " 1, 1884	860

APPENDIX V.

List of periodicals subscribed for :—

American Journal of the Medical Sciences.
Athenæum.
Atlantic Monthly.
Blackwood's Magazine.
Brain.
British Quarterly Review.
Builder.
Century Magazine.
Contemporary Review.
Critic.
Edinburgh Review.
English Mechanic.
Fortnightly Review.
Graphic.
Lancet.
London Quarterly Review.
Longman's Magazine.
Macmillan's Magazine.
Mind.
Nature.
Nineteenth Century.
North American Review.
Popular Science Monthly.
Princeton Review.
Punch.
Scientific American.
Scientific American Supplement.
Times, Weekly.
Westminster Review.

To the above have been added for the current year :—

Illustrated London News.
Saturday Review.
English Illustrated Magazine.
Harper's Monthly Magazine.
The Week.

The following were discontinued at the end of 1883 :—

The Builder.
St. James's Gazette.
Critic.
The Medical News.

APPENDIX VI.

Periodicals presented to the Institute, and the names of the donors :—

Das Echo—W. H. VanderSmissen, Esq., M.A.
Le Temps, Paris—Dr. C. W. Covernton.
Spectator—Prof. Hutton.
Le Figaro, for 1883.
Le Courrier de l'Europe, for 1884. } Geo. E. Shaw, Esq., B.A.

On motion of Mr. J. C. Dunlop, seconded by Mr. Alan Macdougall, the Report was adopted.

The following Officers and Members of Council nominated at last meeting were elected for the ensuing year :

President, W. H. Ellis, Esq., M. A., M. B.
First Vice-President, George Murray, Esq.

Second Vice-President, George Kennedy, Esq., M. A., LL.D.
Third Vice-President, E. A. Meredith, Esq., LL.D.
Treasurer, John Notman, Esq.
Recording Secretary, James Bain, jun., Esq.
Corresponding Secretary, W. H. VanderSmissen, Esq., M. A.
Librarian, George E. Shaw, Esq., B. A.
Curator, David Boyle, Esq.

MEMBERS OF COUNCIL.

James Loudon, Esq., M. A., F. R. S. C.
J. M. Buchan, Esq., M. A.
Alan Macdougall, Esq., C. C., F. R. S. C.
P. H. Bryce, Esq., M. A., M. D.
Daniel Wilson, Esq., LL.D., F. R. S. E., F. R. S. C.
Alexander Marling, Esq., LL.B.

On motion of W. H. VanderSmissen, M. A., it was resolved: "That in Section III, Par. 6, of the Regulations, the words "an Editor" * be inserted after the word "Librarian."

It was moved by Mr. Alan Macdougall, and seconded by Mr. B. B. Hughes: "That the thanks of the Institute be presented to Mr. J. M. Buchan, the retiring President, in recognition of his valuable services rendered during the past year." Carried.

It was moved by Mr. Macdougall seconded by Dr. Cassidy: "That the thanks of the Institute be tendered to the retiring members of the Council in recognition of their valuable services during their term of office." Carried.

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* The Rev. Henry Scadding, D.D., was elected Editor at a meeting of Council held on May 31st, 1884.

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N. B.—The additional Plates which should have appeared in the present Fasciculus will be given in another Number, shortly to be issued. Great disappointment has been occasioned to the Editing Committee by the long-continued delay in the execution of these Plates by the Heliotype Printing Company of Boston.

The Illustration to Prof. Wright's paper on Demodex will also be supplied hereafter, in cases where it may not be included in the present Number.

VOL. I. FASCICULUS No. 5.

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N. B.—The Plates omitted in Fasciculus No. 4, accompany the present Number.

MARCH, 1884.

VOL. II. FASCICULUS No 1.

21 OC. 23. 76.

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Where necessary in Vol. I., place the Plates with the Papers which they illustrate.

JULY, 1884.

VOL. II. FASCICULUS No. 2.

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CONTENTS:

(For continuation of Contents, see second page of cover.)

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CONTENTS—(*Continued*).